Sunnyvale East Channel and Sunnyvale West Channel Flood Protection Project

Planning Study Report

June 2010

Santa Clara Valley Water District℠

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SANTA CLARA VALLEY WATER DISTRICT

SUNNYVALE EAST CHANNEL AND SUNNYVALE WEST CHANNEL FLOOD PROTECTION PROJECT

Project No. 26074002

PLANNING STUDY REPORT

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EXECUTIVE SUMMARY

Introduction

The Sunnyvale East Channel and Sunnyvale West Channel Flood Protection project (SEW Project) was initiated by the District as part of the Clean, Safe Creeks, and Natural Flood Protection Program (CSC Program), which was approved by the voters in November 2000. The project addresses flooding and erosion problems along the channels. Erosion along the channels is pervasive and flooding has occurred in the 1960's, 1980's and 1990's. The Channels were constructed by the District between 1959 and 1967 to convey urban runoff from the City of Sunnyvale's storm drain system to the bay.

The main purpose of this report is to present the details of the staff-recommended alternative for meeting the project objectives to provide flood and erosion protection to Sunnyvale East and West Channels. Summarized below, the project objectives are consistent with the Clean, Safe Creeks program.

Project Objectives

The main objectives of the SEW Project are listed here.

- Provide 100-year riverine flood protection to 1,618 parcels in the Sunnyvale East Channel Watershed and to 47 acres (11 parcels) of industrial and government lands in the Sunnyvale West Channel Watershed by December 2016.

- Provide erosion protection measures thereby improving water quality. The project shall restore, at a minimum, the 25 erosion sites identified in the 2004 West Valley Watershed Creek Inspection Report.

Project Alternatives Considered

The project team developed several feasible alternatives which meet the project objectives. They are:

- Alternative B - Floodwalls, Levees and Erosion Protection
- Alternative D – Detention, Floodwalls, Levees and Erosion Protection
- Alternative H - Pond A4, Floodwalls, Levees and Erosion Protection
- Alternative I - Pond A4, Levees and Erosion Protection
- Alternative J - Pond A4, Detention, Floodwalls, Levees and Erosion Protection
- Alternative K- Pond A4, Detention, Levees and Erosion Protection

There are four flood protection elements used in the feasible alternatives: Floodwalls, Levees, Pond A4, and Detention. These elements distinguish the alternatives from each other as the alternatives all have the same erosion protection element (which consists of rocking the channel toe and vegetating the earth bank). The Floodwalls and Levees elements involve raising the height of existing channel banks, thus providing flood protection by increasing channel capacity. The Pond A4 element involves realigning the channels to flow into Pond A4, which would serve as a detention basin for temporarily storing storm flows. This element would provide flood protection by removing the channels from tidal influence and also from the potential for receiving backwater flows from Calabazas and San Tomas Aquino Creeks during high flow events. Lastly, the Detention element involves diverting peak storm flows into a storage facility and provides flood protection by reducing the peak flows to the channel. The project team identified one site suitable for serving as a detention facility along Sunnyvale East Channel at Braly Park and School in Sunnyvale.

Recommended Project

The project team recommends Alternative H (see Figure 1 for a map), based on its comparison of the alternatives via the District's Natural Flood Protection (NFP) evaluation process, a risk analysis performed by the project team, and the project team's own judgment, as discussed in Chapter 5. Alternative H involves constructing floodwalls and levees and using Pond A4 as a detention basin.

Alternatives D, I, and K were eliminated during the NFP evaluation process. Alternatives I and K were eliminated primarily due to their costs. Because they employed the exclusive use of levees to increase channel capacity, the required right of way acquisition would have been expensive. Alternative D was eliminated due to higher costs of construction and higher maintenance requirements. Although the remaining Alternatives, B, H and J rated similarly in the NFP evaluation, after completing a risk analysis Alternative H was chosen as the recommended project because it provides the most comprehensive and cost-effective flood and erosion protection.

Alternative H is the least expensive of the three alternatives and provides flood protection by the use of two mechanisms (both increasing channel capacity and reducing the starting water surface elevation in the channel) instead of one (increasing channel capacity). Specifically, it increases channel capacity by raising floodwalls and reduces flows to the channel by removing them from tidal influence (thus, preventing tidal flows from entering the channels downstream) and from receiving potential backwater flows from San Tomas Aquino and Calabazas Creeks which could enter the channel during high flow events from the West Valley Watershed. Additionally, the floodwall heights are much shorter than Alternative I or K. Although Alternative J employs these same flood protection mechanisms, it was judged that the benefits of constructing the proposed flood detention basin at Braly Park were not worth the additional cost.

Sensitive Habitats and Special Status Species

Pond A4 and Guadalupe Slough support a variety of sensitive habitats as well as special status species. Potential impacts from the project to these habitats and sensitive species associated with construction activities and modification of the existing hydraulic regime must be fully evaluated and discussed with applicable regulatory agencies. A variety of regulatory permits will be required for the project to move forward, including permits from U.S Fish and Wildlife Service, U.S. Army Corp of Engineers, California Department of Fish and Game and the Regional Water Quality Control Board.

In addition, preliminary investigations have indicated that there are water quality issues in Pond A4 associated with elevated metal concentrations that could impact wildlife. Further evaluation and discussions with the regulatory agencies will have to be completed to address the potential issues associated with water quality at the site.

Public Outreach

During the project's planning phase, the project team incorporated input from both internal and external stakeholders into the development and evaluation of its feasible alternatives. Notably, the project team has sought public input through a combination of flyers, surveys, and public meetings. In addition, the project team has initiated dialogue with regulatory agencies to investigate potential permitting issues.

Right of Way Acquisition Required for Project Construction

It is expected that strips of land from 3 parcels along Sunnyvale East Channel and from 3 parcels along Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative H.

Along Sunnyvale East Channel, lands to be acquired to construct Alternative H would include commercial properties (parking), parks and recreation facilities (Fair Oaks Park), and the open space property owned by the City of Sunnyvale located on the East bank between Highway 101 and Tasman Drive.

Along Sunnyvale West Channel, lands to be acquired to construct Alternative H would include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Sunnyvale Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted by the right of way acquisitions.

Estimated Cost, Financing, and Schedule

The estimated cost for project design and environmental documentation for the staff-recommended alternative is $5 million. The estimated cost of construction and land acquisition is approximately $37 million in 2010. Based on current construction cost escalation rates in the District's Capital Improvement Plan, the cost to construct this project beginning in 2013 is estimated at $40 million plus an additional $3 million for land acquisition. The total allocation from the CSC Program for these two projects is $43 million. At the time of construction, staff may request the Board to allocate unspent funds from other CSC capital projects to complete this project work.

In addition, annual maintenance for the staff-recommended alternative is expected to cost $50,000. The total cost over the 50-year life span of the project, assuming a 3.7% compounding escalation rate, would be $7.3 million. Project design is expected to begin in FY 2010-11 and is anticipated to be completed in early 2013. Construction would be conducted in 2013 and 2014.

Project Implementation

If the Board elects to authorize staff to continue the project work the following milestones have been developed as next steps for project implementation:

- Commence design plans and specifications preparation: August 2010
- Complete CEQA analysis: June 2012
- Complete permit acquisition and design plans and specifications: February 2013
- Commence construction: June 2013

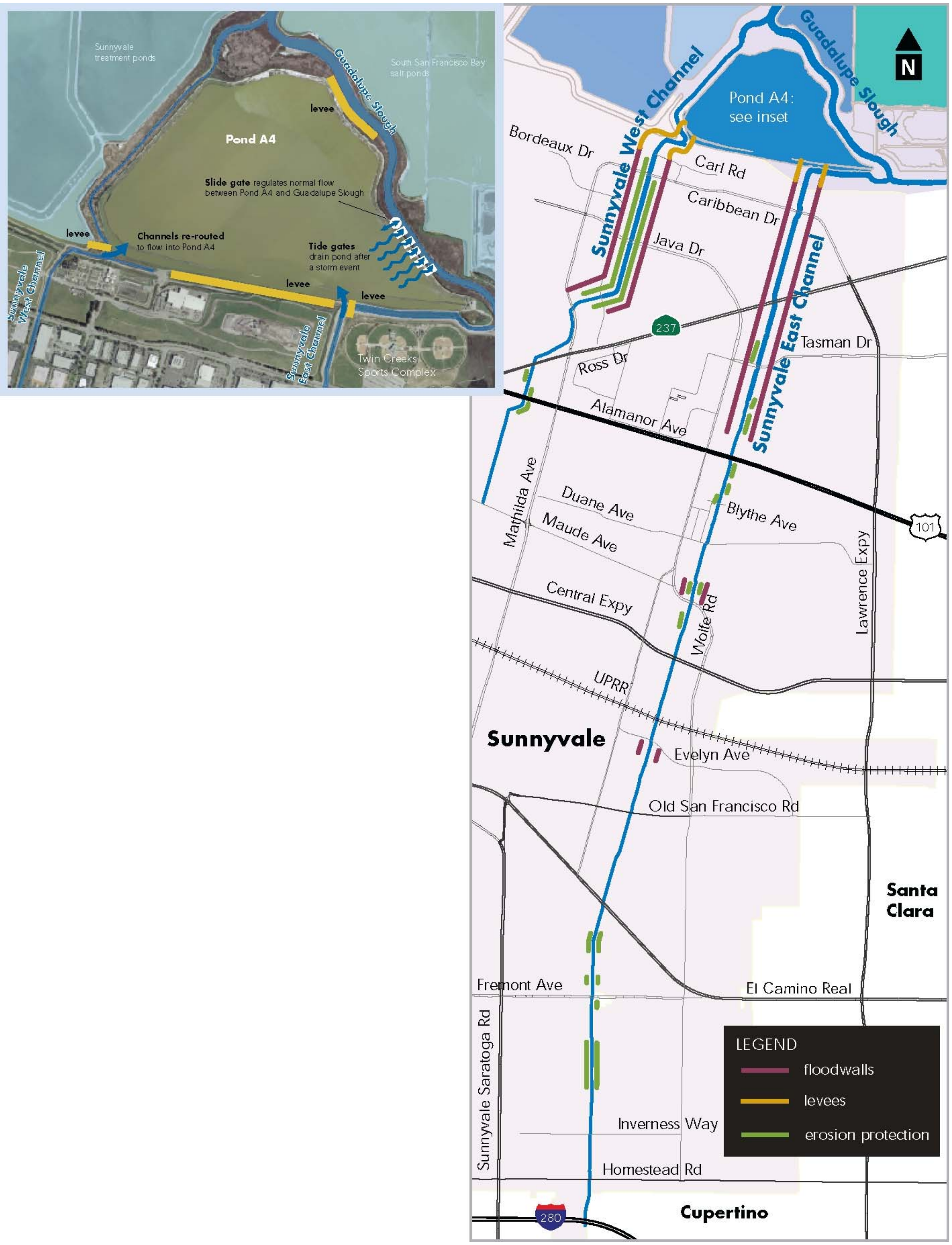

Figure 1. Map showing the elements of the Staff Recommended Alternative (Alternative H)

Introduction

1.1 Purpose and Organization of the Planning Study Report

This is the Planning Study Report for the Sunnyvale East Channel and Sunnyvale West (SEW) Channel Flood Protection Project. The purpose of this report is to document the project objectives, flooding and erosion problems, the development and evaluation of solutions to these problems, and provide a staff-recommend alternative to solve these problems. This report includes the following:

- Project Origins, Objectives, and Location (Chapter 1)
- Study Background (Chapter 2)
- Problem Definition (Chapter 3)
- Project Outreach (Chapter 4)
- Formulation and Evaluation of Alternatives (Chapter 5)
- Staff-Recommended Project (Chapter 6)
- Description of the Maintenance Program (Chapter 7)
- Project Cost, Funding, and Schedule (Chapter 8)
- Conclusions and Recommendations (Chapter 9)

1.2 Project Origin

In November 2000, the voters approved the Clean, Safe Creeks, and Natural Flood Protection Program (CSC Program), which provides funding to improve flood and erosion protection for channels and creeks within the District's jurisdiction. As part of this program, the District initiated the Sunnyvale East Channel Flood Protection Project and the Sunnyvale West Channel Flood Protection Project to address erosion and flooding problems; the projects have been combined as the SEW Project for the Planning Phase.

The SEW Channels were constructed by the District between 1959 and 1967 to convey urban runoff from the City of Sunnyvale's storm drain system to the San Francisco Bay. Erosion along the channels, which lack an upstream natural watershed, is extensive. Flooding along the channels has occurred in the 1960's, 1980's and 1990's.

1.3 Project Objectives and Relevant Board End Policies

The mission of the District is to provide a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally sensitive manner.

The objectives of the SEW Project are listed below:

- Provide 100-year riverine flood protection to 1,618 parcels in the Sunnyvale East Channel Watershed and to 47 acres of industrial and government lands in the Sunnyvale West Channel Watershed by December 2016. *CSC Program Commitment and Board Ends Policy E-2, Article 2.2—"There is a reduced potential for flood damages."*

- Provide erosion protection measures thereby improving water quality. The project shall restore, at a minimum, the 25 erosion sites identified in the 2004 West Valley Watershed Creek Inspection Report. *Ends Policy E-3, Article 3.1—"Watersheds, streams, and the natural resources therein are protected and when appropriate enhanced or restored."*

- Identify environmental and recreational enhancement opportunities for consideration by the Board. *CEO Interpretation (December 15, 2009) of Ends Policy E4.1.2 – "Improve Watersheds, Streams, and Natural Resources"*

- Revise the FEMA flood hazard maps to reflect 100-year flood protection along the improved channels to eliminate the requirement for flood insurance in this community by July 2017.

1.4 Project Location

As delineated in Figures 2 and 3, the SEW Project area limits include all of the SEW Channels and are located primarily within the City of Sunnyvale. The Sunnyvale East Channel (Figure 2) extends approximately 6 miles from its confluence with Guadalupe Slough to the limit of District jurisdiction at Junipero Serra Channel, flows from south to north, and drains 7.25 square miles. The Sunnyvale West Channel (Figure 3) extends approximately 3 miles from its confluence with Guadalupe Slough to the limit of District jurisdiction at Maude Avenue, flows from south to north, and drains 7.6 square miles.

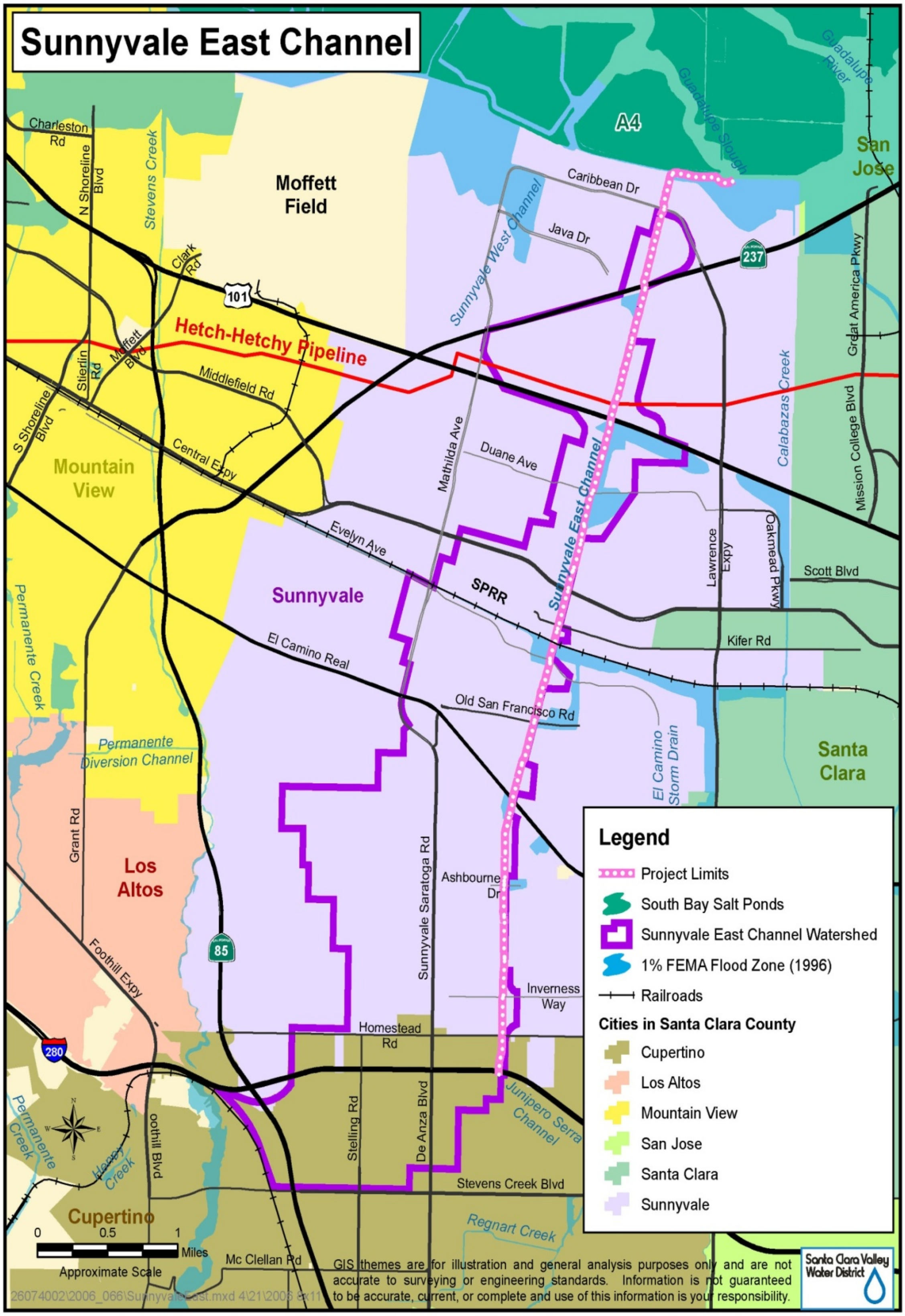

Figure 2. Map of Sunnyvale East Channel

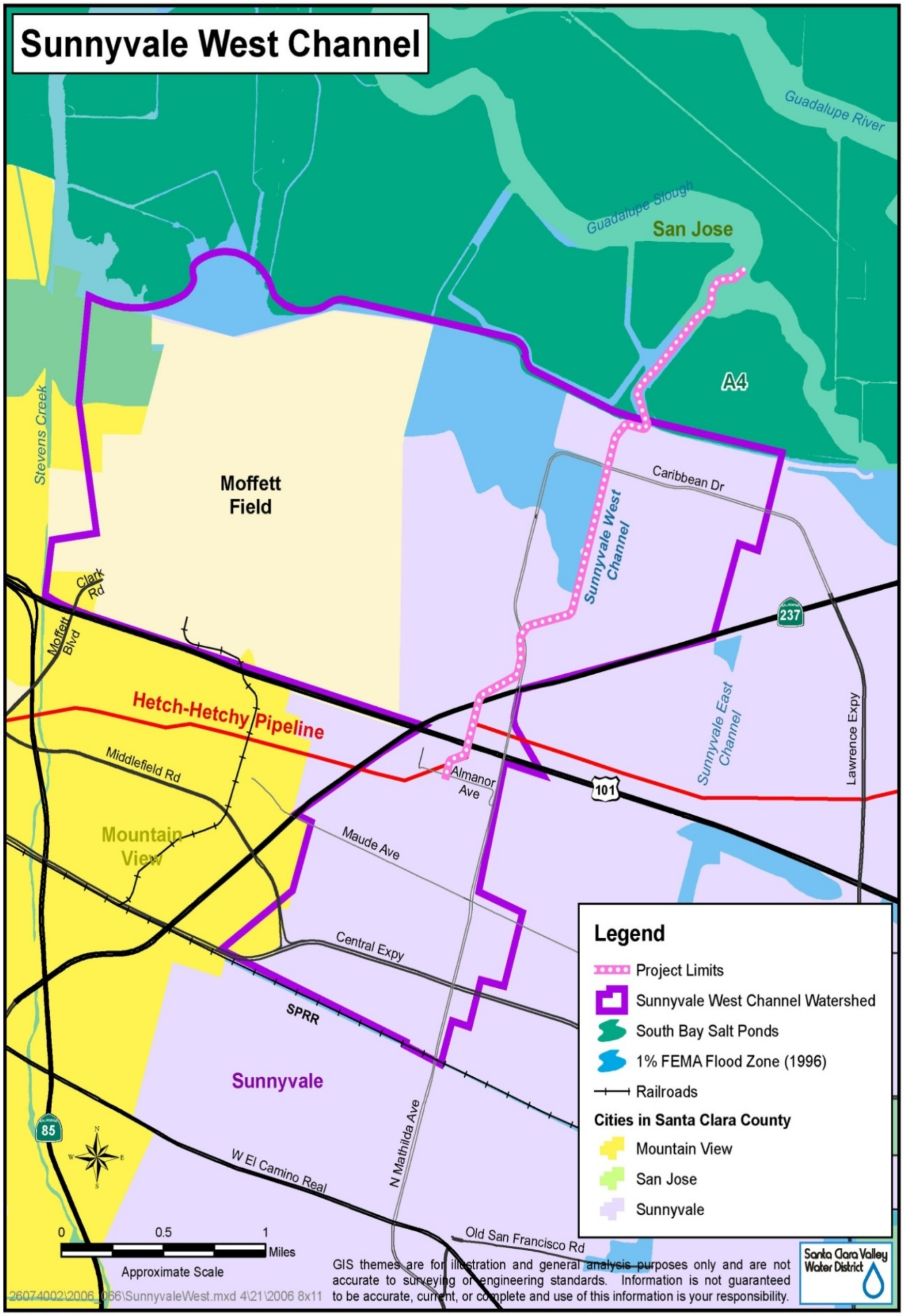

Figure 3. Map of Sunnyvale West Channel

2 Study Background

This chapter provides descriptions of the SEW Channel watersheds. Information on the channels, watershed hydrology, geology, utilities, biological resources, hazardous materials, and related projects is provided in the following sections.

2.1 Description of the Channels

2.1.1 Map of Channel Reaches

For planning purposes, SEW Channels have been divided into reaches, as shown in Figure 4 and described in Sections 2.1.2 and 2.1.3. Although the reaches were delineated for uniformity of channel characteristics such as cross section dimensions, slope, and hardscape, erosion and flooding problems can vary significantly within each reach, and similar erosion and/or flooding problems may occur within different reaches.

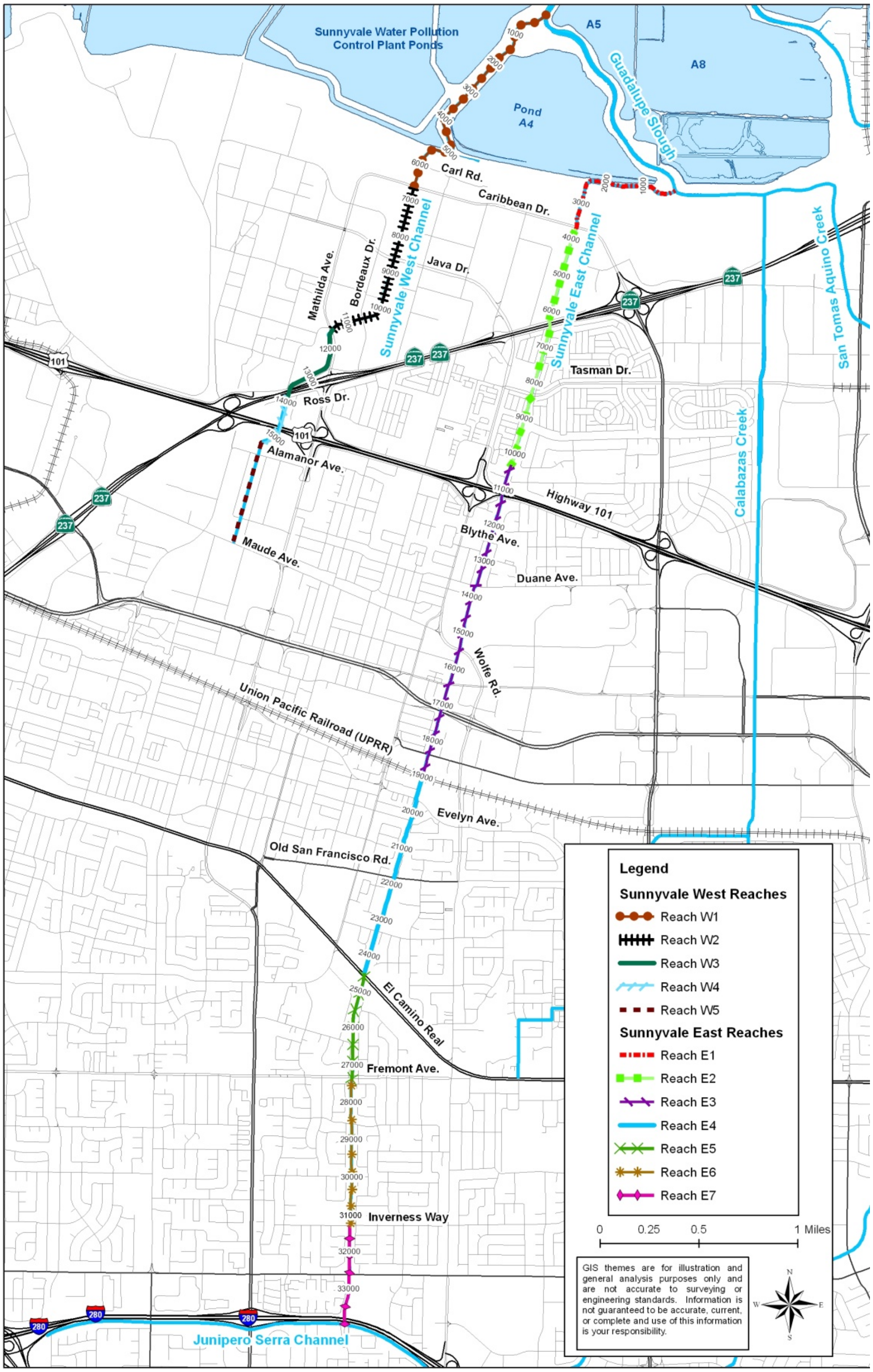

Figure 4. Map of Reaches for Sunnyvale East and West Channels

2.1.2 Sunnyvale East Channel

The Sunnyvale East Channel extends approximately 6.5 miles from the confluence with Guadalupe Slough to Junipero Serra Channel, flows from south to north, and drains a watershed area of approximately 7.25 square miles. The channel is tidally influenced from Guadalupe Slough to approximately Tasman Drive. Sunnyvale East Channel can generally be characterized as a channel with straight-alignment and trapezoidal cross section with side slopes of 1.5:1 horizontal:vertical (H:V) to 2:1, an average depth of 10-feet, and bed width varying from about 7 to 30 feet. The channel has been divided into seven reaches as defined below and delineated in Figure 4:

Reach E1 Confluence with Guadalupe Slough to Caribbean Drive (0.7 miles)
Reach E2 - Caribbean Drive to US Highway 101 (Highway 101) (1.25 miles)
Reach E3 - Highway 101 to Union Pacific Railroad Crossing (1.6 miles)
Reach E4 - Union Pacific Railroad Crossing (UPRR) to El Camino Real (1.0 mile)
Reach E5 - El Camino Real to Fremont Avenue (0.5 miles)
Reach E6 - Fremont Avenue to Inverness Way (0.75 miles)
Reach E7 - Inverness Way to Interstate 280 (0.75 miles)

The channel has a distinctly different character for portions located north of Highway 101 (Reaches E1 and E2) as compared to portions located south of Highway 101 (Reaches E3 through E6). Reaches E1 and E2 are mostly earthen, collectively have 4 bridge crossings (one concrete culvert, two bridges with piers, and a pedestrian bridge), are very flat with invert slopes ranging from 0% to 0.1%, and are tidally influenced downstream of the location roughly halfway between Tasman Drive and Highway 101 (where the channel invert intersects the mean-higher-high-water mark). By contrast, reaches E3 through E6 have alternating stretches of earthen, hardscaped, or lined channel (generally with concrete or sacked concrete), a high density of road crossings (18, all concrete culverts), and multiple drop structures and/or hydraulically steep ramps (most as part of the culverts) capable of inducing critical or supercritical flow.

Reaches E1 through E6 are open channel reaches, while Reach E7 is a pipe that connects to a diversion structure at Junipero Serra Channel. Table 1 below gives a description of the general characteristics of each reach. Explanations of column headers are provided at the bottom of the table for those which are not self explanatory. Following the table are photos (Figures 5 to 10) characterizing the channel in each reach. A more detailed discussion of the channel characteristics is available in the Problem Definition Report, Appendix A (SCVWD 2008a).

Table 1. Existing Reach Characteristics for Sunnyvale East Channel

			Channel Characteristics						
Reach	**Downstream Extent of Reach**	**Upstream Extent of Reach**	**Length (mi)**	**Tidally Flushed**	**Number of Bridges**	**Number of Drop Structures and Ramps**	**Percent of Hardscape**	**Past Mantenance Costs ($ per linear ft)**	**Levees**
E1	Guadalupe Slough Confluence	u/s face Caribbean Dr.	0.7	YES	2	0	0%	unknown	YES
E2	u/s face Caribbean Dr.	d/s face Caribbean Dr.	1.25	YES	2	0	13%	unknown	YES
E3	d/s face Caribbean Dr.	d/s face UPRR	1.6	NO	8	5	58%	39	NO
E4	d/s face UPRR	d/s face El Camino Real	1	NO	4	7	76%	44	NO
E5	d/s face El Camino Real	d/s face Fremont Ave.	0.5	NO	2	2	37%	5	NO
E6	d/s face Fremont Ave.	d/s face Inverness Way	0.75	NO	4	1	21%	15	NO
E7	d/s face Inverness Way	I-280	0.5	NO	N/A	N/A	N/A	N/A	NO

Number of Bridges: This is the number of bridges within each reach. All of the bridges on Sunnyvale West Channel are concrete culverts.

Number of Drop Structures and Ramps: The number of drop structures within each reach is self explanatory. Specifically, ramps refer to hydraulicaaly steep entrance ramps leading to culvert entrances. Drop structures may occur either within the open channel area or within each culvert.

Percent of Hardscape: This refers to the percentage of the reach length which is lined with hardscape (in general, either with concrete, sacked-concrete, or geocell), either as part of a culvert under a road crossing, a wingwall, or a section of lined

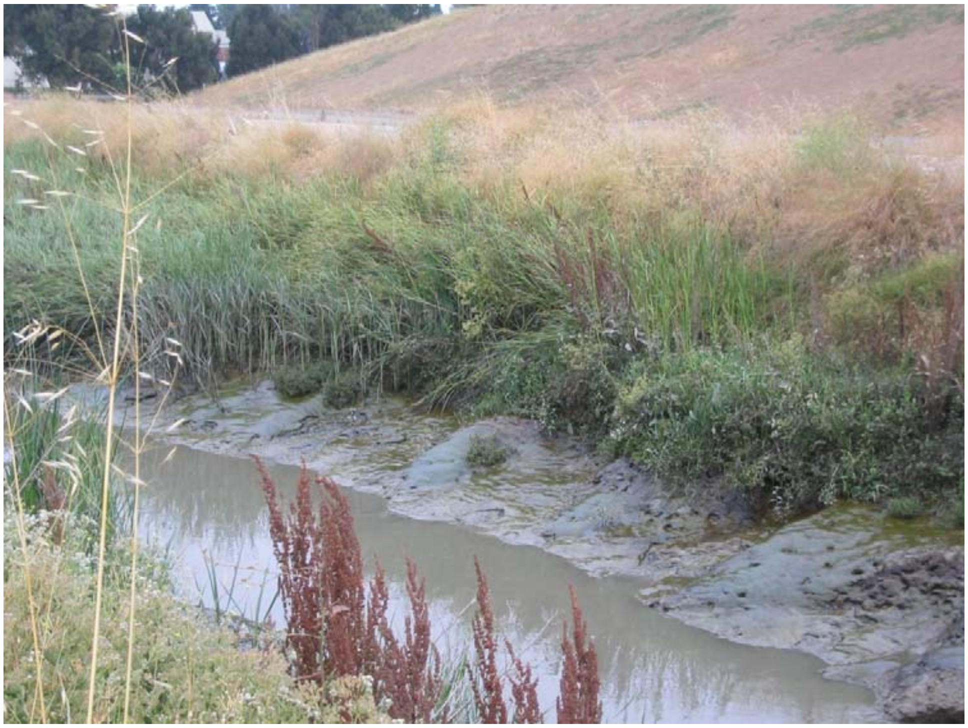

Figure 5. Reach E1, Earthen Channel in tidal zone: Looking south (upstream) from a location north of Caribbean Drive, note bay mud bottom and brackish tidal vegetation.

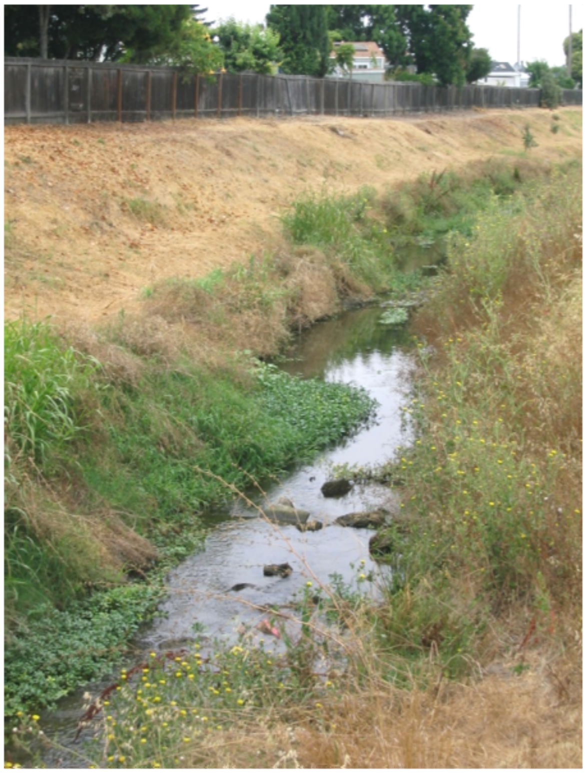

Figure 6. Reach E2, Earthen Channel outside of tidal zone: Looking north (downstream) from Highway 101.

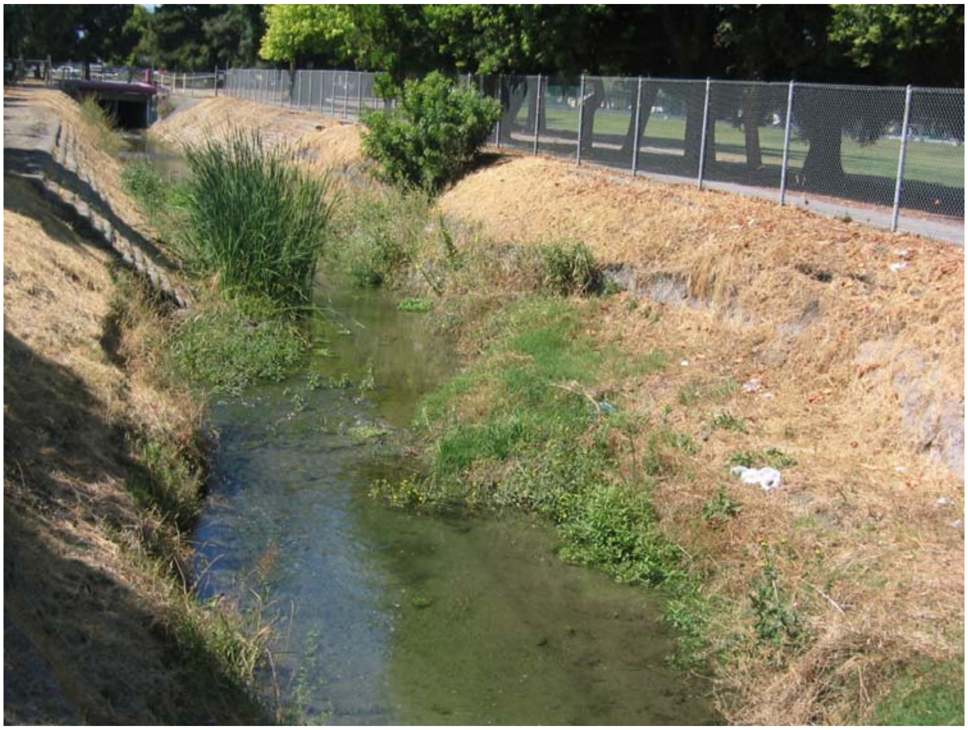

Figure 7. Reach E3, Reach with alternating lined and earthen channel: Looking south (upstream) from Duane Avenue towards Wolfe Road. Note severe bank erosion.

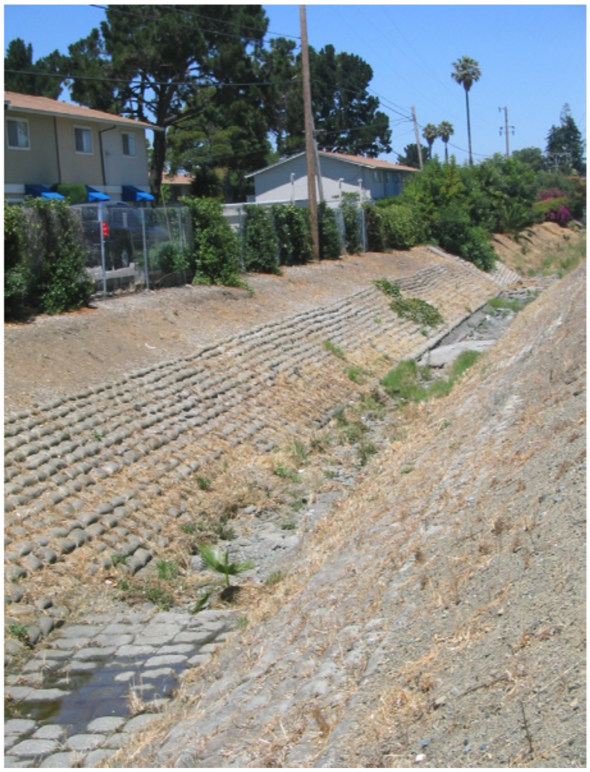

Figure 8. Reach E4, Channel lined with sacked concrete, earthen channel in the distance: Looking north (downstream) from a location downstream of Old San Francisco Road

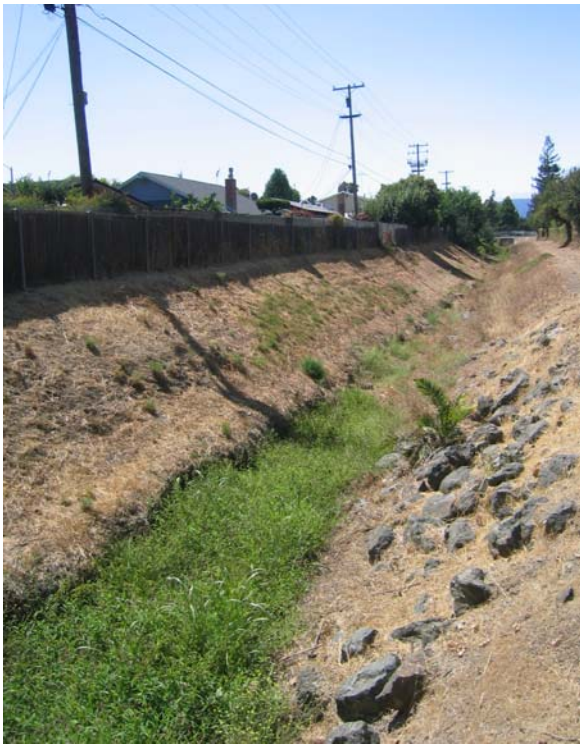

Figure 9. Reach E5, Channel banks strengthened with buried rock, earthen channel in the distance: Looking south (upstream) from Crescent Avenue

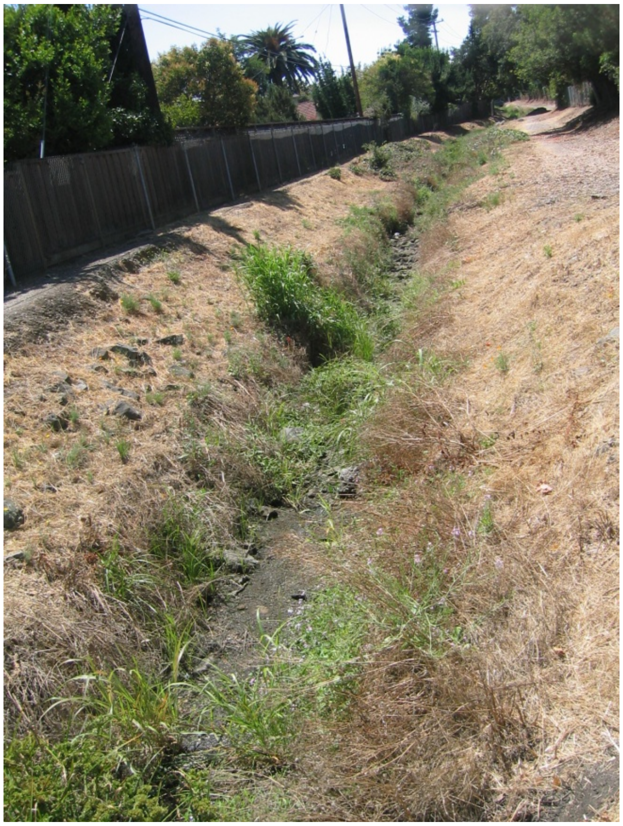

Figure 10. Reach E6, Earthen Channel: Looking upstream (south) from Dunholme Way.

2.1.3 Sunnyvale West Channel

The Sunnyvale West Channel extends approximately 3 miles from the confluence of the Guadalupe Slough to Maude Avenue, also flows from south to north, and drains a watershed area of approximately 7.6 square miles. The channel is tidally influenced from Guadalupe Slough to Mathilda Avenue. The channel has been divided into five reaches as defined below:

Reach W1 – Confluence with Guadalupe Slough to Caribbean Drive (1.2 miles)
Reach W2 - Caribbean Drive to Mathilda Avenue (0.9 miles)
Reach W3 - Mathilda Avenue to Ross Drive (0.5 miles)
Reach W4 - Ross Drive to Alamanor Avenue (0.3 miles)
Reach W5 - Alamanor Avenue to Maude Avenue (0.1 miles)

Apart from a half-mile long underground box culvert/u-frame channel extending south from Mathilda Avenue to Highway 101 and day lighting at Ross Drive, the channel is an earthen, trapezoidal channel with a primarily straight alignment containing only one major bend north of its crossing with Bordeaux Drive. The channel cross section is generally similar in dimensions to Sunnyvale East Channel, with side slopes varying from 1.5:1 to 2:1 (H:V), bed widths from 5 to 30 feet, and an average channel depth of 11 feet (with variations from 7 to 16 feet).

Table 2 below gives a description of the general characteristics of the Sunnyvale West Channel reaches depicted in Figure 4. Explanations of column headers are provided at the bottom of the table for those which are not self explanatory. This is followed with photos (Figures 11 to 13) illustrating the typical channel characteristics of each reach. A more detailed discussion of the channel characteristics is available in the Problem Definition Report, Appendix A (SCVWD 2008a).

Table 2. Existing Reach Characteristics for Sunnyvale West Channel

			Reach Characteristics						
Reach	Downstream Extent of Reach	Upstream Extent of Reach	Length (mi)	Tidally Flushed	Number of Bridges	Number of Drop Structures and Ramps	Percent of Hardscape	Past Mantenance Costs ($ per linear ft)	Levees
W1	Guadalupe Slough Confluence	u/s face Caribbean Dr.	1.2	YES	2	0	3%	unknown	YES
W2	u/s face Caribbean Dr.	d/s face Mathilda Ave.	0.9	YES	2	0	7%	unknown	YES
W3	d/s face Mathilda Ave.	u/s face Ross Dr.	0.5	NO	2	0	100%	unknown	NO
W4	u/s face Ross Dr.	d/s face Alamanor Ave.	0.3	NO	2	0	16%	unknown	NO

Number of Bridges: This is the number of bridges within each reach. All of the bridges on Sunnyvale West Channel are concrete culverts.

Number of Drop Structures and Ramps: The number of drop structures within each reach is self explanatory. Specifically, ramps refer to hydraulicaaly steep entrance ramps leading to culvert entrances. Drop structures may occur either within the open channel area or within each culvert.

Percent of Hardscape: This refers to the percentage of the reaach length which is lined with hardscape (in general, either with concrete, sacked-concrete, or geocell), either as part of a culvert under a road crossing, a wingwall, or a section of lined channel.

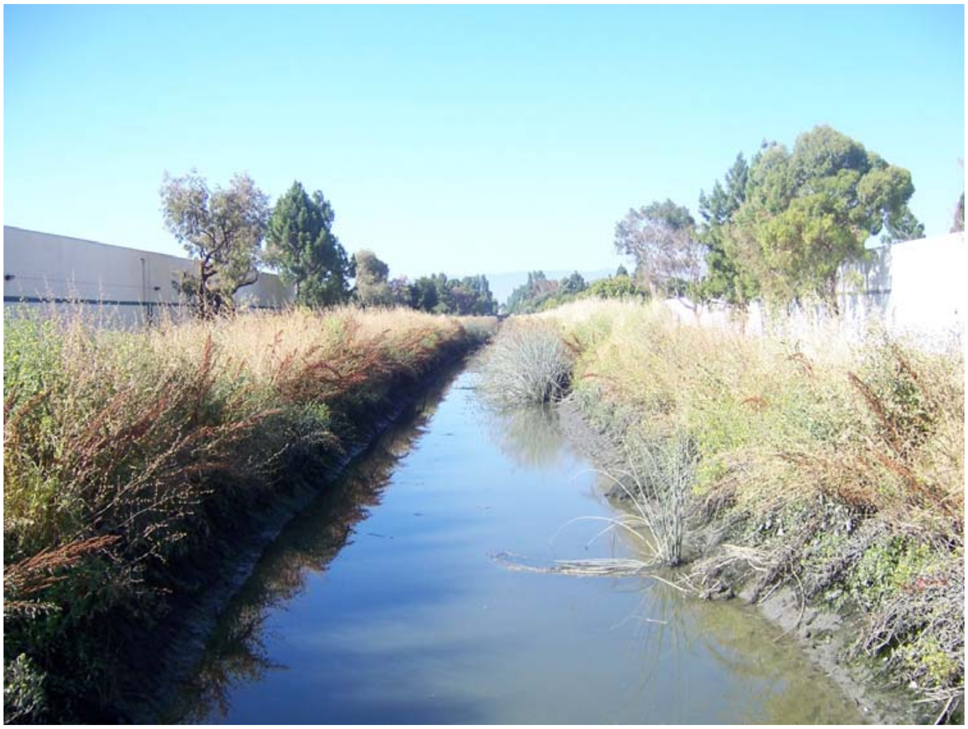

Figure 11. Reach W1, Earthen Channel in tidal zone: Looking south (upstream) towards Carl Road

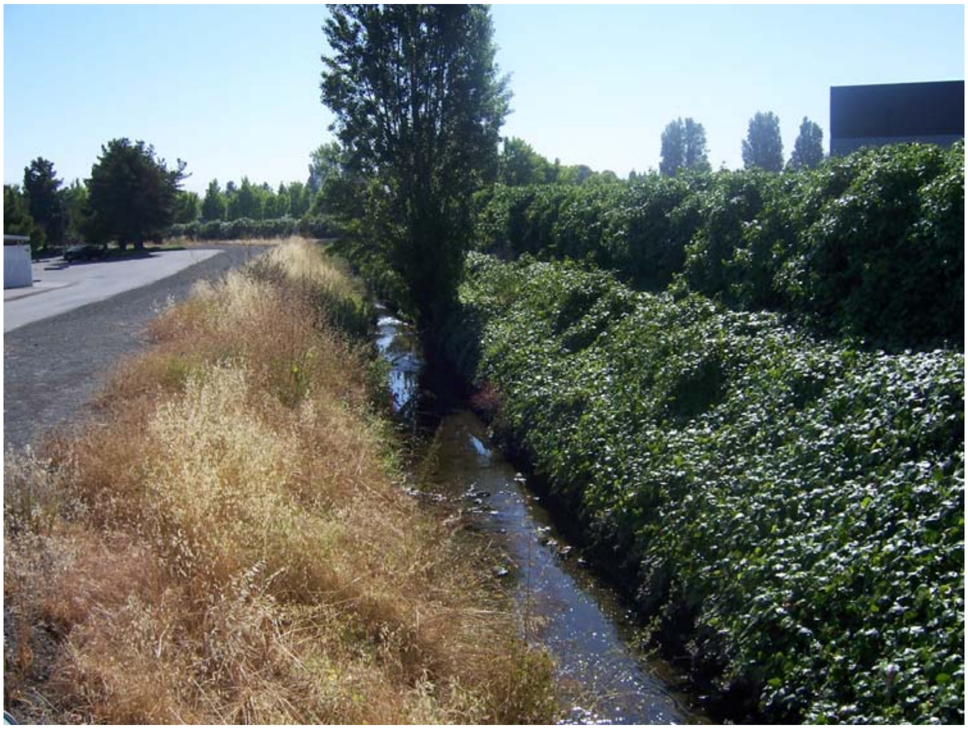

Figure 12. Reach W2, Earthen channel in zone weakly influenced by the tides: Looking south (upstream) from Bordeaux Drive

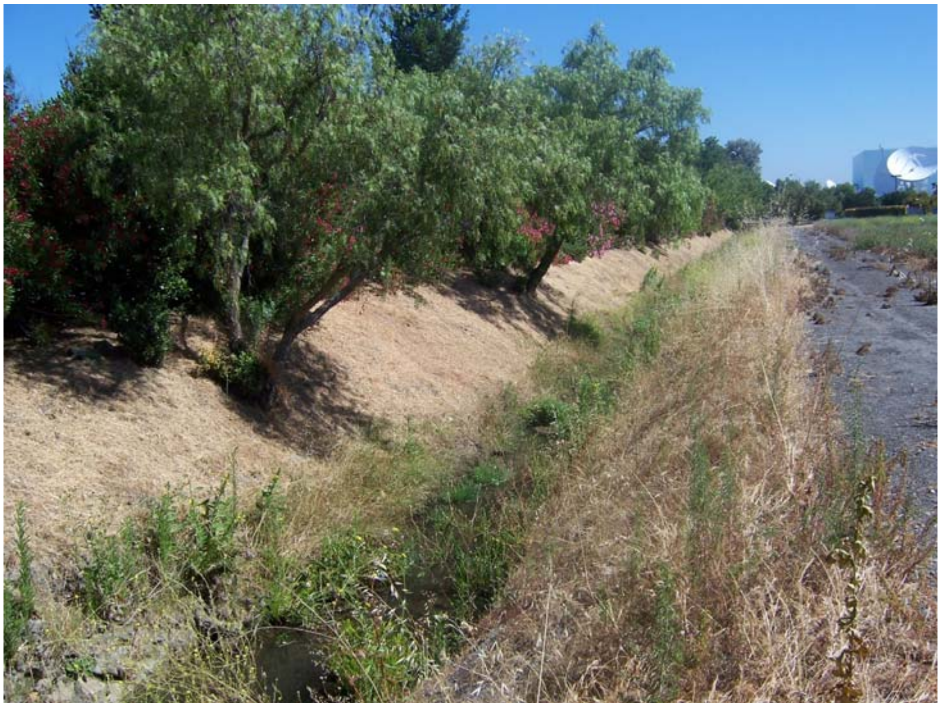

Figure 13. Reach W4, Earthen Channel, looking north (downstream) from the Highway 101 road crossing.

2.2 Hydrology

2.2.1 Historical Background

Prior to the 1900's, rainfall and resulting storm water runoff in the area now know as Sunnyvale would naturally drain into Stevens Creek or Calabazas Creek. Artesian well and groundwater well pumping for agricultural use between the early 1900's and the 1950's resulted in eight to ten feet of surface subsidence in the northern portion of Sunnyvale. The subsidence caused the natural drainage pattern to be disrupted. Consequently flows that would naturally drain into Stevens Creek or Calabazas Creek now pooled between the two creeks, causing flooding.

In order to prevent this flooding, the District decided to construct two artificial channels to provide drainage to the bay for a significant portion of Sunnyvale between Calabazas Creek and Stevens Creek. These channels were constructed from 1959 to 1967 and are now the Sunnyvale West Channel and Sunnyvale East Channel; they drain to Guadalupe Slough, which drains to the bay. They were constructed as integral parts of the City's storm drain system.

2.2.2 General Watershed Description

The Sunnyvale East and West channels are located in Santa Clara County in the West Valley Watershed. The West Valley Watershed is an 85-square-mile area encompassing portions of Sunnyvale, Cupertino, San Jose, Santa Clara, Campbell, Saratoga, Monte Sereno, and Los Gatos. The West Valley Watershed has no reservoirs and contains Sunnyvale East Channel, Sunnyvale West Channel, Calabazas Creek and San Tomas Aquino Creek. As shown in Figure 14, Calabazas and San Tomas Aquino creeks drain the majority (81%) of the watershed's 85 square miles. All of the conduits drain from south to north, empty into Guadalupe Slough, and are subject to tidal influence in their downstream reaches. In addition, SEW Channels are potentially subject to backwater flows from Calabazas and San Tomas Aquino creeks during large storm events; this is due to the fact that their confluences with Guadalupe Slough are located downstream of those for Calabazas and San Tomas Aquino creeks. The main characteristics of each channel and its associated watershed are listed in Table 3 below.

Table 3. Characteristics of Sub-Watersheds within the West Valley Watershed

Conduit Name	Sunnyvale West Channel	Sunnyvale East Channel	Calabazas Creek	San Tomas Aquino Creek
Length*	3	6	13	16
Watershed Area *	8**	7	21	45
Approximate Percentage of Total Watershed Area (%)	10**	9	26	55
Percent Rural or Pervious (%)***	23	25	35	48
Land Use	Downstream half is industrial; upstream half is medium density residential	Mostly medium density residential; some industrial	Most upstream parts are rural; middle is medium density residential; downstream area is industrial/commercial	Most upstream parts are rural, middle and downstream parts are a mix of low to medium density residential and commercial
*Length and watershed area are rounded to the nearest mile or square mile. ** More than half of Sunnyvale West channel's watershed area drains to storage areas, and is pumped into the channel near the location of the south-west corner of Pond A4. *** Calculated as the sum of pervious and rural areas divided by total watershed area; values obtained from District's HEC-1 model.				

As noted in Table 3, more than half of Sunnyvale West's watershed area drains to two pump stations, Lockheed Pump Station and the City of Sunnyvale's Pump Station Number One, which discharge into Sunnyvale West Channel at locations just north of its crossing with Carl Road. In addition to receiving flows from these two pump stations, Sunnyvale West Channel also receives flows from the Sunnyvale Water Pollution Control Plant (WPCP). Estimated pump rates during 100-year flows on Sunnyvale West Channel are provided in Section 2.3.2 below.

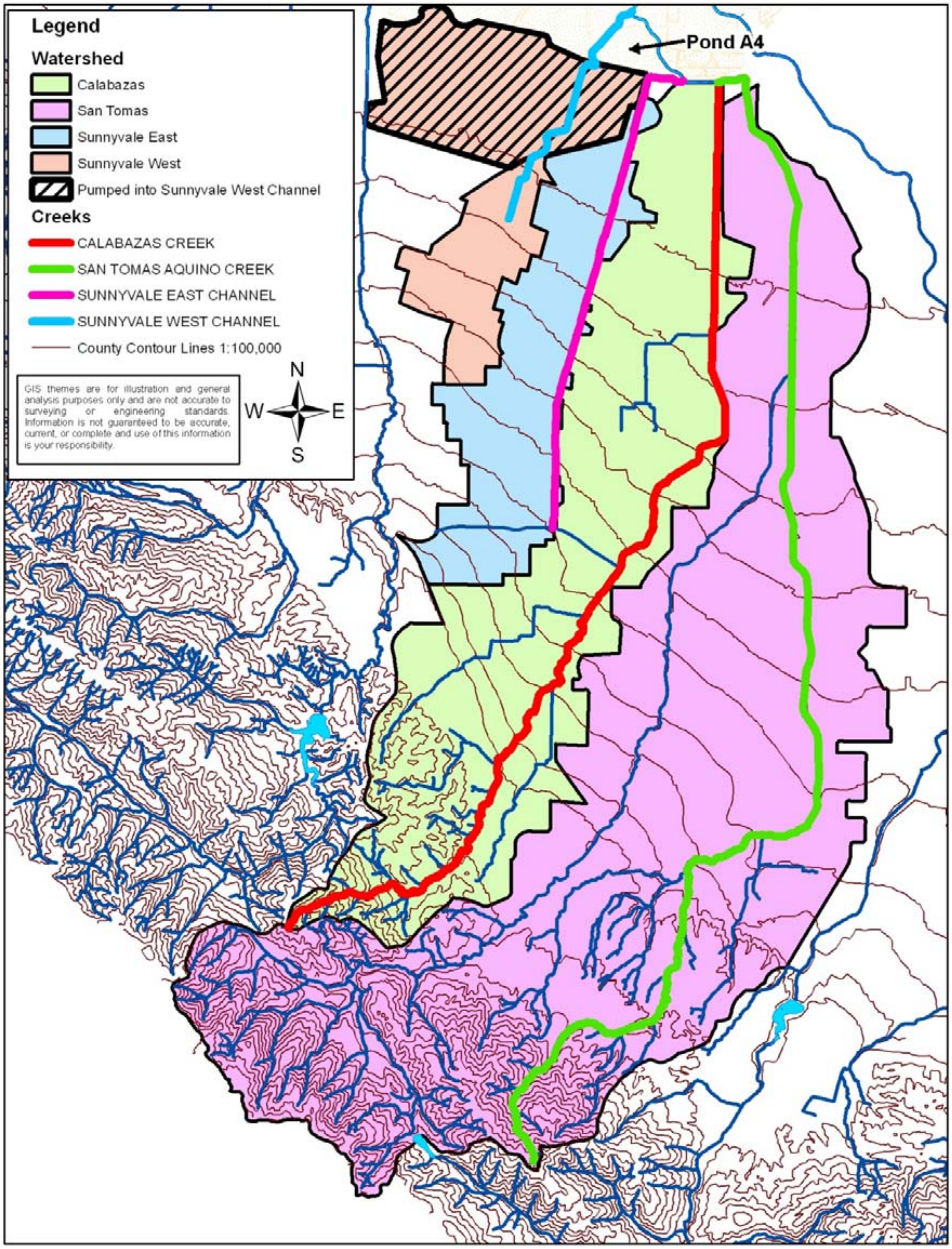
Legend
Watershed
Calabazas
San Tomas
Sunnyvale East
Sunnyvale West
Pumped into Sunnyvale West Channel
Creeks
CALABAZAS CREEK
SAN TOMAS AQUINO CREEK
SUNNYVALE EAST CHANNEL
SUNNYVALE WEST CHANNEL
County Contour Lines 1:100,000
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
N
W
E
S
Pond A4

Figure 14. Sub-watersheds within the West Valley Watershed

2.2.3 Design Flows

The 10 and 100-year design flow distributions for the SEW Channels are provided in Tables 4 and 5 below, respectively. These flow distributions were generated with HEC-1 models of the two watersheds using standard District procedures and were validated with both hand calculations and data collected from stream gage #74 located upstream of Highway 101 on Sunnyvale East Channel. The flow distribution for Sunnyvale West Channel does not include flows from Lockheed pump station, the City of Sunnyvale's Pump Station Number 1, or the WPCP. The project team has communicated with Lockheed Martin and the City of Sunnyvale to determine reasonable estimates of flow rates from the two pump stations and the WPCP during a 100-year flow event on Sunnyvale West Channel; these values are provided in Table 6. The flows on the channels are a reflection of their relatively small watershed sizes within the West Valley Watershed and are small when compared with flows on Calabazas and San Tomas Aquino Creeks, as shown in Table 7.

Table 4. 10-Year and 100-Year Design Flows for the Sunnyvale East Channel

Location	Cumulative Drainage Area (mi^2)	Peak Flow (cfs)	
		10-year (10%)	100-year (1%)
Sunnyvale East Channel at Homestead Road (SE-A)	1.55	170	190
Sunnyvale Diversion to Calabazas Creek (via Junipero Serra Channel)	**	80	90
Sunnyvale East Channel at Fremont Avenue (SE-B)	2.78	310	440
Sunnyvale East Channel at El Camino Real (SE-C)	3.64	430	560
Sunnyvale East Channel at Old San Francisco Road (SE-D)	4.20	540	740
Sunnyvale East Channel d/s E. Arques Road (SE-E)	5.30	690	890
Sunnyvale East Channel d/s Highway 101 (SE-F)	6.34	780	980
Sunnyvale East Channel d/s Highway 237 (SE-G)	7.09	880	1100
Sunnyvale East Channel d/s Caribbean Drive (SE-H)	7.25	900	1100

Source: SCVWD, 2008 Hydrology Unit design flow report

Table 5. 10-Year and 100-Year Design Flows for the Sunnyvale West Channel

Location	Cumulative Drainage Area (mi^2)	Peak Flow (cfs)	
		10-year (10%)	100-year (1%)
Sunnyvale West Channel d/s El Camino Real (SW-A)	0.45	70	90
Sunnyvale West Channel at Evelyn Avenue (SW-B)	1.49	160	190
Sunnyvale West Channel at Maude Avenue (SW-C)	2.05	260	310
Sunnyvale West Channel d/s Highway 237 (SW-D)	2.81	320	380
NOTE: Drainage from the most downstream part of the Sunnyvale West Watershed, 4.8 square miles in extent, enters the channel at the downstream end via the City of Sunnyvale Pump Station Number 1 and the Lockheed Pump Station.			

Source: SCVWD, 2008 Hydrology Unit design flow report

Table 6. Estimated Pumping Rates into Sunnyvale West Channel during a 100-year Flow Event

Facility	Current Pumping Rate (as quoted from Agency)	Total Estimated Pumping Rate during a 100-year Flow Event (cfs)	Discharge Location	Data Source
City of Sunnyvale, Water Pollution Control Plant	Average daily discharge: 13-15 MGD; Maximum Discharge: 40 MGD	61.89 cfs	Approximately 600 feet downstream (i.e., north-east) of Carl Road	Communication with the City of Sunnyvale (emails are in the Project Files)
City of Sunnyvale, Pump Station Number 1	Two pumps running simultaneously at 19500 gal/min and 27500 gal/min	104.72 cfs	Into the upstream end of the spur channel, located near the south-west corner of Pond A4	
Lockheed Martin, Lockheed Pump Station	69 cfs total pumping capacity; pumping during a 100-year flow event would be 20 cfs	20 cfs	Approximately 350 feet downstream (i.e., north-east) of Carl Road	Communication with Lockheed Martin

Table 7. Flow Rates for Adjacent Creeks in the West Valley Watershed

Creek	Total Watershed Area (sq. mi)	Percent Urbanized (%)	10-Year Flow @ confluence with Guadalupe Slough (cfs)	100-year Flow @ confluence with Guadalupe Slough (cfs)
Sunnyvale West Channel	2.81	100	320	380
Sunnyvale East Channel	7.25	100	900	1100
Calabazas Creek	22.7	10	2650	3900
San Tomas Aquino Creek	44.9	20	6000	9200

Source: SCVWD 2006a

2.3 Geology

In general, north of the Union Pacific Railroad (UPRR) near Central Expressway, the Channels are underlain by Alluvium comprising unconsolidated stream and basin deposits, which typically consist of interbedded clays and sands. South of the UPRR, Sunnyvale East Channel is underlain by Older Alluvium comprising dissected alluvial deposits, which typically consist of sands with clay lenses (SCVWD, 2008b and 2008c).

The watershed draining to Sunnyvale East Channel is located on the alluvial plain below the uplands of the Santa Cruz Mountains, part of the Coast Range. The deposits in the lower portion of Sunnyvale East Channel consist of alluvial basin deposits of Quaternary (Holocene) age. Bay mud deposits exist north of the Bayfront Levee and along Guadalupe Slough. The alluvial basin deposits are clay to very fine silty-clay with carbonate nodules. The next western portion of the watershed consists of alluvial fan and fluvial deposits of Quaternary (Holocene) age and Holocene age flood-plain deposits. The fan deposits consist of brown or tan gravelly sand or sandy gravel, which grades upward to sandy or silty clay. The flood-plain deposits consist of dark-gray sandy to silty clay with occasional lenses of coarse material from silt to sand or gravel. The western end of the watershed is underlain by Quaternary (Pleistocene) age alluvial fan deposits, which are gravelly to clayey sand grading upward to sandy clay (SCVWD, 2005).

The Monte Vista Fault crosses the far southwest corner of the land draining into the Sunnyvale East Channel. This fault is one of the major faults in the San Francisco Bay area, and is essentially parallel to the San Andreas Fault, located farther to the west. Both are right lateral, strike-slip faults (SCVWD, 2005).

2.4 Utilities

As both channels run through an urban environment of a major city, a plethora of utilities run adjacent to or over them. The relocation, protection, or avoidance of these utilities could have a significant impact on work in or around the Channels.

Sunnyvale East Channel

The typical utilities are expected to cross the Sunnyvale East Channel at major road crossings. In addition, there are known utilities running over or adjacent to the channel. Significant utilities include:

- From Guadalupe Slough to Iris Avenue (Reach E1, E2, E3, and E4) - High-tension overhead electric lines and high-pressure gas transmission lines are within an easement adjacent to and over the channel.
- From Tasman Drive to Highway 101 (Reach E2) – City of Sunnyvale water transmission lines run adjacent to the channel and SFPUC's Hetch-Hetchy water conduits cross the channel. An electric sub-station is adjacent to the channel in this area.
- From Kifer Road to UPRR (Reach E3) – An electric sub-station is adjacent to the channel in this area.

Sunnyvale West Channel

Typical utilities are expected to cross the Sunnyvale West Channel at major road crossings. In addition, there are known utilities running over or adjacent to the channel. Significant utilities include:

- Downstream of Caribbean Avenue (Reach W1) – Utilities for the WPCP operations, landfill operations, FAA tower operations, Pond A4 operations, Sunnyvale Storm Drain Pump Station operations, and the Northern Channel Pump Station operations are crossing or adjacent to the channel. High-tension overhead electric lines also cross the channel in the area.
- From Bordeaux Drive to Mathilda Avenue (Reach W2) – AT&T's central office and many communication conduits are in the area.
- From Ross Drive to Alamanor Avenue (Reach W4) – SFPUC's Hetch-Hetchy water conduits run adjacent to and cross the channel.

2.5 Biological Resources

The Sunnyvale East and West Channels both originate and flow northward through a mix of urban, business park, and light industrial settings before reaching the brackish marsh habitat associated with Guadalupe Slough. Introduced annual grass and ruderal (weedy) nonnative species dominate the levee banks on both channels from their upstream origins downstream to approximately Highway 237 on the Sunnyvale East Channel and West Java Drive on the Sunnyvale West Channel. Within these same reaches of channels, seasonal aquatic vegetation periodically appears in the flooded bed of the channels and along the water's edge (EDAW 2007).

Areas with tidal influence and connection to the slough provide the greatest habitat value and constitute the area with the highest probability of supporting sensitive species. Adjacent to Guadalupe Slough, Pond A4 is surrounded by an extensive network of salt ponds, sloughs, and channels fringed with brackish marsh vegetation. The pond is characterized by a large area of open water that provides habitat to wildlife species that require open water for foraging, such as waterfowl, pelicans, and shorebirds that used the mudflats along the edges of the pond. Vegetation around the pond consists of a narrow strip of middle salt marsh habitat dominated by native pickleweed (*Salicornia virginica* and perhaps with *S. subterminalis*). (Titus 2007). The levees above the pickleweed support a mix of nonnative annual grass and annual ruderal plants, much like those found in other terrestrial areas around the project area. Although areas near the top of the levee roads are highly degraded, sensitive salt marsh habitat and other wetland vegetation occur throughout the lower reaches of the project area and in Pond A4.

Sensitive Species and Sensitive Habitats

A variety of sensitive species have the potential to occur in the project area, especially in the project area associated with Pond A4 and Guadalupe Slough. Sensitive habitats in that area include brackish tidal marsh and salt marsh. The salt marsh habitat fringing Pond A4 has the potential to support the federally endangered and state endangered and fully protected salt marsh harvest mouse (*Reithrodontomys raviventris*). Other listed species with the potential to occur in the Pond A4 and Guadalupe Slough area include the federally threatened western snowy plover (*Charadrius alexandrinus nivosus*) , federally endangered and state endangered and fully protected California least tern (*Sternula antillarum browni*), the state threatened and fully protected California black rail (*Laterallus jamaicensis coturniculus*) and the federally endangered and state endangered and fully protected California clapper rail (*Rallus longirostris obsoletus*). Other sensitive species that may utilize the channels in the project footprint include burrowing owls and other sensitive raptors and western pond turtles.

Anticipated Impacts

Pond A4:
It is expected that incorporation of project elements involving modifications to Pond A4 could result in potential impacts to the existing habitat and sensitive species in the area. Opening up Pond A4 to tidal flow will modify the existing hydraulic regime that may in turn affect the salt marsh habitat around the pond by making the water less saline. This may result in the conversion of salt marsh habitat to a more brackish marsh habitat over time. While no net loss of wetland habitat is expected, conversion of the more rare and high value salt marsh habitat to a more common brackish marsh habitat is potentially significant (Titus 2010). Habitat conversion from the project may also potentially impact salt marsh dependent species such as

the salt marsh harvest mouse and California clapper rail. Further data collection and analysis is required to determine the extent of these potential impacts and will be evaluated during the project design.

Guadalupe Slough and Sunnyvale Channels:
Potential impacts from the project associated with Guadalupe Slough and the channels are anticipated from the following: 1.) Fill due to berm or levee construction to move flows into Pond A4; 2.) Reduced depth, duration, and frequency of tidal flooding upstream of the proposed berms or levees; and 3.) Potential impacts from increased sedimentation. It is too difficult to predict the changes in wetland area caused by increased sediment deposition until further data is collected and analyzed. Sediment deposition from San Francisco Bay tidal waters could be substantial and are consistent with a reduced tidal prism and sedimentation experienced at other sites. Sedimentation rates will vary within the different channel areas and will need to be further evaluated. There are substantial wetland areas downstream of the proposed berm bordering the Sunnyvale West channel that would be highly vulnerable to increased sediment accumulation. Sediment removal that would impact wetlands beyond the current management practices also needs to be determined as newly established wetland vegetation may require on-going removal to maintain hydraulic capacity. Blocking tidal waters from moving upstream beyond Pond A4 as occurs in the existing condition is predicted to reduce wetland habitat on the Sunnyvale East channel. No net loss of wetland vegetation is expected in Sunnyvale West Channel, however vegetation is expected to fill in the center of the channel. Further data collection and analysis is required to determine the extent of these potential impacts and will be evaluated during the project design.

2.6 Hazardous Materials (Soil and Water)

Prior to the construction of the channels between 1959 and 1967, the land along the channel alignments was primarily agricultural (row crops and orchards). Currently, most properties adjacent to the Sunnyvale West Channel are developed for commercial use. A mix of residential and commercial properties currently borders the Sunnyvale East Channel. Commercial businesses that are common in the site area that may pose potential environmental concerns include research and development facilities, electronic component manufacturing firms and similar business that use and/or store hazardous materials; several such businesses were identified as reported spill incidents.

Studies of nearby channels, including the Northern Channel, the Moffett Channel, and channels associated with Pond A4, detected contaminants including pesticides, polychlorinated biphenyls (PCBs), metals and polynuclear aromatic hydrocarbons (PAHs) in levee soil and channel sediment (TRC, 2007). Because these channels are nearby or adjacent to the SEW Channels and are similar in construction and use (primarily used for storm water drainage), it appears reasonable to conclude that similar contaminants, at similar concentrations, may also be present in levee soil and sediment within the SEW Channels.

The detected contaminants are most likely from non-point sources associated with urban runoff, as well as past agricultural activities. Additionally, the Sunnyvale WPCP effluent is discharged into the northern portion of the Sunnyvale West Channel. Some of the contaminants, such as pesticides, may be present along the entire length of the channels since the land along the channel alignments historically was primarily agricultural. The other potential contaminants including PCBs, metals, and PAHs, if present, would be expected to be at their highest concentrations near and downstream of commercially developed areas that are more common in the northern portion of the project area.

Several spill incidents that have impacted groundwater, mainly with volatile organic compounds (VOCs), were identified near the channel alignments. Based on the information reviewed, it appears likely that groundwater below most of the Sunnyvale West Channel is impacted with VOCs. VOCs have also been reported in groundwater near portions of the Sunnyvale East Channel.

Although existing sampling data from the SEW Channels is limited, the data reviewed from studies of the nearby Northern Channel and Pond A4 suggests that contaminant concentrations are likely to be relatively low when compared to hazardous waste criteria or human health screening levels. The reported concentrations, however, have commonly exceeded screening levels and/or established site-specific cleanup goals developed for the protection of ecological receptors.

2.7 Related/Nearby Projects

This section briefly describes past and present studies, projects, and programs that are relevant to the project.

South San Francisco Bay Shoreline Study

The South San Francisco Bay Shoreline Study (Shoreline Study) is a Congressionally-authorized study being performed by the U.S. Army Corps of Engineers (Corps) together with local sponsors to identify and recommend for Federal funding one or more projects for flood damage reduction, ecosystem restoration and related purposes such as public access.   The Shoreline Study will be funded through a partnership among the Corps, the District, and the Conservancy. The U.S. Fish and Wildlife Service and other land-owning agencies within the project area are also involved in the planning process.

The study is being performed through several “Interim Feasibility Studies”, the first of which will investigate flood protection for all Santa Clara County Baylands, from Palo Alto to Alviso, in addition to the restoration of former salt production ponds within the Alviso Pond complex and adjacent properties such as areas around Moffett Field.

Various flood protection strategies will be examined, such as increasing flood capacities of local creeks by widening the mouths of waterways and reestablishing historical flood plains. Although flooding risks from individual creeks have been reduced by a number of existing projects in the area, the Shoreline Study area remains vulnerable to tidal flooding. In Santa Clara County, there are several streams that carry runoff through the valley and north to San Francisco Bay. The two largest rivers — the Guadalupe River and Coyote Creek —have been retrofitted to provide flood protection to most communities along their banks, including the community of Alviso in north San Jose. However, it is the Shoreline Study that will examine tidally induced flooding in these communities.

To help guide the ecosystem-restoration and flood protection aspect of the planning effort, the Shoreline Study will incorporate findings from the South Bay Salt Ponds Project (SBSP). The Corps and the District are active project management team members of the SBSP Project. Extensive coordination has occurred, and will continue to occur, between the two projects.

The Shoreline Study project area is also the area to which the Sunnyvale East and West Channels drain. The Shoreline Study could provide tidal flood protection to the area. There is synergistic effort with the District as described above.

South Bay Salt Pond Restoration Project

The South Bay Salt Pond Restoration Project (SBSP Project) is a currently active project encompassing approximately 15,100 acres of former salt ponds located around the edge of South San Francisco Bay. The SBSP Project is led by the California State Coastal Conservancy (Conservancy), the U.S. Fish and Wildlife, and the California Department of Fish and Game. The SBSP Project is the largest wetlands restoration project on the West Coast of the United States. The SBSP Project is intended to restore and enhance wetlands in South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The SBSP Project objectives are:

1. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to:
   - Promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.
   - Maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees.
   - Support increased abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles and amphibians.
2. Maintain or improve existing levels of flood protection in the South Bay Area.
3. Provide public access and recreational opportunities compatible with wildlife and habitat goals.
4. Protect or improve existing levels of water and sediment quality in the South Bay, and take into account ecological risks caused by restoration.
5. Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species, and manage the spread of nonnative invasive species.
6. Protect the services provided by existing infrastructure (e.g., power lines, railroads).

The Sunnyvale East Channel and Sunnyvale West Channel drain to the South Bay via Guadalupe Slough, which travels through the SBSP Project area. The SEW Project Team communicates with the District's Project Manager for the SBSP Project on a regular basis.

Onizuka Air Force Station

The Onizuka Air Force Station is located at 1080 Innovation Way in Sunnyvale off Mathilda Avenue just north of State Route 237 and U.S. 101. The facility is currently operated by the United States of America. The campus consists of 23 acres, with 24 buildings on site. In 2005, Onizuka AFS was recommended for closure by the Department of Defense (DOD) and the Base Realignment and Closure (BRAC) Commission, and endorsed by the president. In 2006, the City of Sunnyvale was formally recognized by the DOD as the Local Redevelopment Authority (LRA). Of the 23-acre site, 2.5 acres will be transferred to the Veteran Affairs (VA) including the headquarter building, storage shed, exchange building, and 100 parking spaces. The remaining 18 acres are designated as "surplus property", and the LRA will plan the future use of the surplus property. Final closure of the station is expected in 2011.

Other District Flood Protection Projects in the West Valley Watershed

The District has performed many projects in the watershed in the past. Major projects are described below:

Past Capital Projects on Calabazas Creek -

- 1979 – A concrete lined channel was constructed between Highway 101 and El Camino Real
- 1979 – The creek was realigned between Stevens Creek Blvd. and Valco Parkway
- 1980 – The creek was enlarged by constructing an earthen channel with levees between Guadalupe Slough and Highway 101.
- 1996 – SF Bay to Miller Avenue, project to provide additional flood protection via flood walls and levee work.
- 2007 – The creek was deepened between Central Expressway and El Camino Real
- 2007 – Weir's were installed to address invert erosion between Miller and Homestead
- 2008 – Calabazas Creek Capacity Improvement Project (Central Expressway to Miller Avenue)
- 2009 – Calabazas Creek: Bollinger Road Bridge Replacement

Past Capital Projects on San Tomas Aquino Creek -

- 1982 – San Tomas Aquino Creek was modified with gabions and rock-lined with levees from Mission College Blvd. to Southern Pacific Railroad line.
- 1983 – Trapezoidal concrete was installed between the Southern Pacific Railroad line and San Tomas Expressway.
- 1996 – San Tomas Aquino Creek's bed between Guadalupe Slough and Mission College Blvd. was created from excavated earth with levees.

Currently in the West Valley Watershed, the District has one active capital projects on Calabazas Creek. A short description of the projects is listed below:

- *Calabazas Creek Flood Protection Project (Miller Avenue to Wardell Road)*. The Calabazas Creek Flood Protection Project will provide flood protection to communities along the Calabazas Creek in the cities of Saratoga, San Jose and Cupertino from Miller Avenue to Wardell Road. The District has constructed flood protection projects on Calabazas Creek from San Francisco Bay to Miller Avenue. The District is in the planning stage to bring flood protection, erosion control, biological enhancements and recreational opportunities to Calabazas Creek south of Miller Avenue. Project construction will be conducted between 2010 and 2013 under the Clean, Safe Creeks Program.

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3 Problem Definition

3.1 Creek Flooding

This section describes the past and current flooding problems along the SEW Channels. It is broken into three sub-sections describing flooding which has occurred along the channels in the past, the existing District floodplain/FEMA Federal Insurance Rate Map [FIRM], and the locations of flooding potential either due to channel overtopping or freeboard deficiency as determined by the project team.

3.1.1 Historic Flooding

Both SEW Channels have a history of recurring floods which have adversely impacted the safety and economic stability of the residents, businesses, and government property within the flood plain. Flooding within the watershed has been documented as far back as 1951, and historical flood events reported for both channels are summarized below.

SEW Project Area – December 1955
A significant flood event occurred throughout the South San Francisco Bay area in late December 1955 that became known as the 1955 Christmas Storm. The northern portions of Sunnyvale between Calabazas Creek and Stevens Creek were inundated as were Mountain View and Palo Alto to the north, and areas of Santa Clara and San Jose to the south. This event pre-dated the construction of the Channels.

Sunnyvale East Channel – January 21-24, 1967
Local ponding occurred in areas discharging to the uncompleted reaches of Sunnyvale East Outfall Channel. The Sunnyvale East Channel was later extended.

Sunnyvale East Channel and Sunnyvale West Channel – January 22-30, 1983
Overtopping of both Channels occurred just upstream of Caribbean Drive. Most of the flooding occurred on parking lots and streets, and water damage to at least one business was reported. A high tide may have influenced the extent of flooding. Overtopping of the Sunnyvale East Channel bank north of Evelyn Avenue also occurred, blocking the access tunnel to California Cannery and Growers. The source of the flooding is unknown.

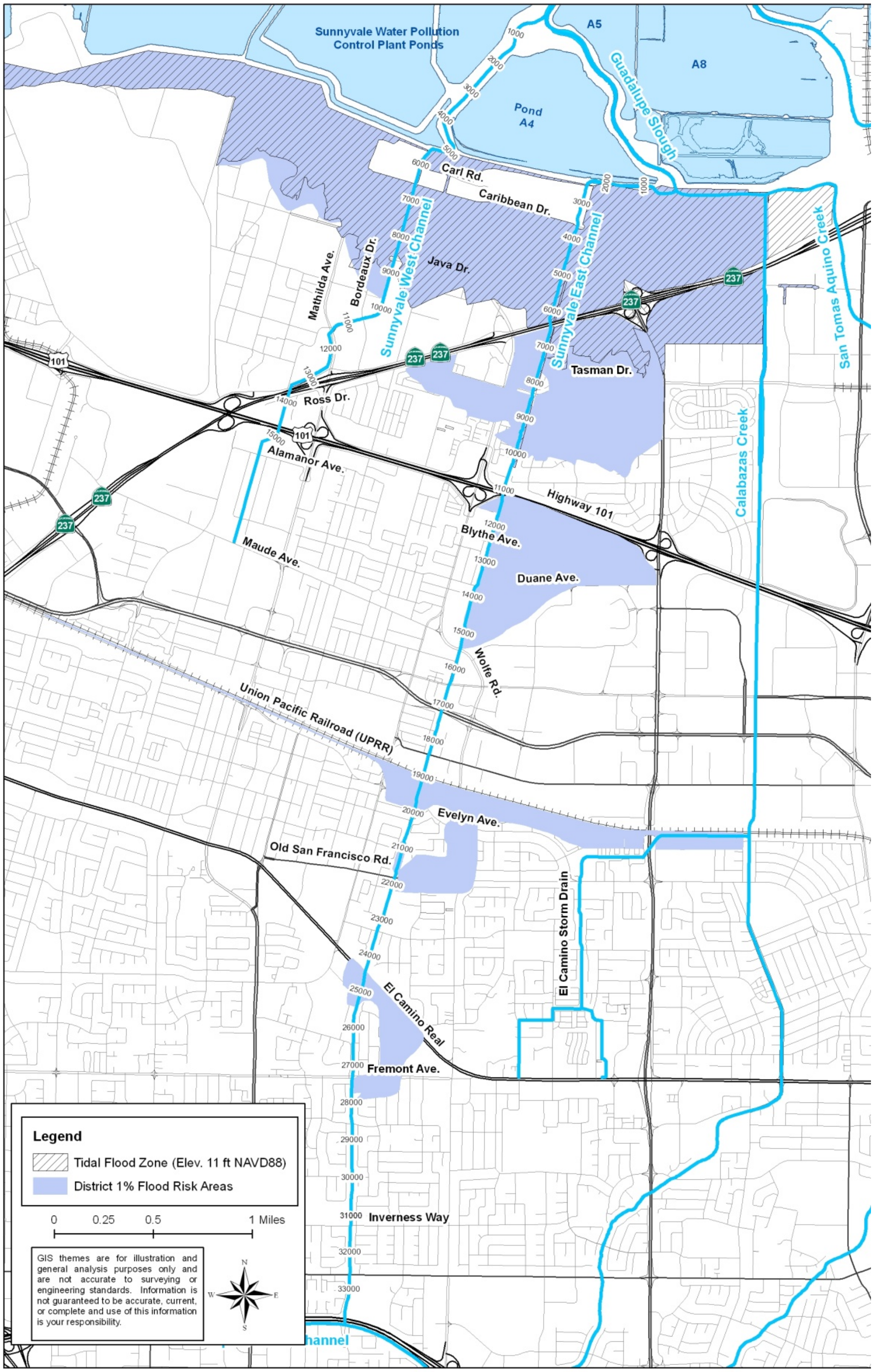
Calabazas Creek and San Tomas Aquino Creek – February 12-20, 1986
Significant overtopping of nearby Calabazas Creek and San Tomas Aquino Creek occurred. Although the flood report for these dates does not mention overtopping of Sunnyvale East Channel, part of the flooded area was adjacent to the portion of Sunnyvale East from its Guadalupe Slough confluence to about 2000 feet upstream.

Sunnyvale East Channel – February 2 - 9, 1998
Overtopping on the Sunnyvale East Channel occurred at Duane Avenue and downstream of Highway 237. Twenty-six businesses and manufacturing properties were flooded.

3.1.2 District Floodplain Map

Figure 15 shows the 100-year (or 1%) floodplain area for SEW Channels. The 100-year floodplain is defined as an area that has a 1% chance of flooding in any given year. The areas delineated as “District 1% Flood Risk Areas” were mapped based on modeling done for FEMA’s previous flood insurance study map revision for the City of Sunnyvale (1997). These areas delineate both the flooding greater than zero feet which would arise from 100-year flows on the SEW Channels and the FEMA 100-year floodplain, which maps areas which would experience more than 1 foot of flooding.

Section 3.1.3 identifies channel overtopping locations along SEW Channels identified by the project team in table format. Due to updated hydraulic modeling, the project team has judged that the areas mapped upstream of Old San Francisco Road do not experience channel overtopping and have adequate freeboard to meet FEMA requirements.


Sunnyvale Water Pollution Control Plant Ponds
A5
A8
Pond A4
Guadalupe Slough
Carl Rd.
Caribbean Dr.
Java Dr.
Bordeaux Dr.
Mathilda Ave.
Sunnyvale West Channel
Sunnyvale East Channel
San Tomas Aquino Creek
Calabazas Creek
Tasman Dr.
Ross Dr.
Alamanor Ave.
Highway 101
Blythe Ave.
Maude Ave.
Duane Ave.
Wolfe Rd.
Union Pacific Railroad (UPRR)
Evelyn Ave.
Old San Francisco Rd.
El Camino Storm Drain
El Camino Real
Fremont Ave.
Inverness Way
237
101
Legend
Tidal Flood Zone (Elev. 11 ft NAVD88)
District 1% Flood Risk Areas
0
0.25
0.5
1 Miles
GIS themes are for illustration and general analysis purposes only and are not accurate to surveying or engineering standards. Information is not guaranteed to be accurate, current, or complete and use of this information is your responsibility.
N
E
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hannel

Figure 15. District 1% Flood Risk Areas

3.1.3 Locations of Channel Overtopping and/or Freeboard Deficiency

Potential locations of flooding and/or freeboard deficiency along the SEW Channels have been identified using hydraulic engineering numerical analysis software (HEC-RAS). Tables 8 and 9 summarize the locations where the channels do not meet freeboard standards (3.5 feet of freeboard in sections of channels with levees, 4 feet of freeboard within 100-feet of structures in sections of channels with levees), lack 100-year flow capacity, or both. In addition, the tables summarize the main cause of the high water. In the table columns, “100-year flow” refers to the 100-year flows originating from the channels’ own watersheds, “tidal currents” refers to the 10-year tide, and “backwater flows from adjacent watersheds” refers to flows coming from Calabazas and San Tomas Aquino Creeks which may backflow into the SEW Channels during an extreme flow event.

The results for maximum freeboard deficiency reported in Tables 8 and 9 were calculated as follows. The freeboard deficiency was determined by first adding the required freeboard to the 100-year water surface elevation and then subtracting the existing bank elevation. For brevity of reporting, only the maximum freeboard deficiency for each section of channel is reported. The required freeboard heights used were: 4 feet within 100 feet of a bridge face of a leveed section, 3.5 feet in the main channel of a leveed section, and 1 foot along non-leveed sections of channel. These criteria are the same as the design criteria listed in Section 6.1. It should be noted that in some sections, it is possible for the channel to have 100-year flow capacity but to lack the required freeboard; for example the water surface could be a half-foot below the bank in a non-leveed section but would still require a half foot of freeboard.

The project steady state HEC-RAS models developed for existing conditions used the 100-year flow distributions in the channels and a downstream starting water surface elevation which would result from simultaneous 100-year flood events on the SEW Channels, Calabazas Creek, and San Tomas Aquino Creek and a 10-year tide; in addition, flows from the pump stations on Sunnyvale West Channel were added at their discharge locations, as described in Section 6.1. The starting water surface was determined with an unsteady HEC-RAS model which modeled this scenario; the starting water surface elevations for the channels were set equal to the maximum water elevations which occurred during the simulated storm at the downstream ends of the SEW Channels. From a physical point of view, the use of this downstream boundary condition translates into capturing both the effects of high tides and backwater effects from Calabazas and San Tomas Aquino Creeks on flooding which could occur during the design storm defined by the project team.

The data sources used for the HEC-RAS models include geometry developed from District topographic surveys performed in 2006-2007; bridge parameters developed from the 2006-2007, survey and construction as-builts for both channels; Manning’s n values assigned according to reconnaissance field trips; and downstream boundary conditions based on a combination of the 2001 U.S. Army Corps of Engineers tidal study and modeling studies conducted by the Project Team. The models have been validated against various data, including stream gage (Stream Gage #74) data collected at Highway 101 and historical flooding events.

Table 8. Sunnyvale East Channel Capacity and Freeboard Deficiency by Reach

Reach	Location		Levees	1% Capacity	Maximum Freeboard Deficiency (ft)	Cause of Overtopping or Freeboard Deficiency
	From (upstream)	To (downstream)				
E7	Highway 280	Inverness Way	No	Yes	N/A	N/A
E6	Inverness Way	Fremont Ave	No	Yes	N/A	N/A
E5	Fremont Ave	El Camino Real	No	Yes	N/A	N/A
E4	El Camino Real	Old San	No	Yes	N/A	N/A
	Old San Francisco Rd.	155 feet upstream of Evelyn Ave.	No	Yes	0.7	Flow
	155 feet upstream of Evelyn Ave.	Evelyn Ave.	No	No	4.6	backwater effects behind Evelyn Ave.
	Evelyn Ave.	UPRR	No	Yes	0.5	100-year flow
E3	UPRR	Central	No	Yes	N/A	N/A
	Central Expressway	Arques Ave.	No	Yes	0.5	backwater effects behind Arques Ave.
	Arques Ave.	Wolfe Rd.	No	Yes	0.2	backwater effects behind Duane Ave. and Wolfe Rd.
	Wolfe Rd.	Duane Ave.	No	No	4.5	backwater effects behind Duane Ave.
	Duane Ave.	Blythe Ave.	No	No	0.6	backwater effects behind Blythe Ave.
	Blythe Ave.	79 feet upstream of Highway 101	No	Yes	N/A	100-year flow
	79 feet upstream of Highway 101	Highway 101	No	No	0.2	backwater effects behind Highway 101
E2	Highway 101	Tasman Dr.	No	No	4.3	100-year flow
	Tasman Dr.	Highway 237	Yes	Yes	2.6	tidal currents, 100-year flow, and/or backwater flows from adjacent watersheds
	Highway 237	Caribbean Dr.	Yes	No	6.3	tidal currents and/or backwater flows from adjacent watersheds
E1	Caribbean Dr.	Confluence with Guadalupe	Yes	No	6.3	

Table 9. Sunnyvale West Channel Capacity and Freeboard Deficiency by Reach

Reach	Location		Levees	1% Capacity	Maximum Freeboard Deficiency (ft)	Cause of Overtopping or Freeboard Deficiency
	From (upstream)	To (downstream)				
W5	Maude Ave.	Alamanor Ave.	Pipe	Yes	N/A	N/A
W4	Alamanor Ave.	Ross Dr.	No	Yes	N/A	N/A
W3	Ross Dr.	Mathilda Ave.	No	Yes	N/A	N/A
W2	Mathilda Ave.	Bordeaux Dr.	Yes	Yes	1.3	100-year flow, tidal currents and/or backwater flows from adjacent watersheds
	Bordeaux Dr.	Java Dr.	Yes	No	3.9	
	Java Dr.	Caribbean Dr.	Yes	No	4.8	
W1	Caribbean Dr.	Carl Rd.	Yes	No	5.6	
	Carl Rd.	Confluence with Guadalupe Slough	Yes	No	4.6	tidal currents and/or backwater flows from adjacent watersheds

Freeboard deficiency heights pertain to above ground elevations

3.1.4 Bridge Capacity

On Sunnyvale East Channel, there are four bridges which would overtop during the design storm adopted by the project team: Caribbean Drive (Reach E1), Duane Avenue (Reach E3), Wolfe Road (Reach E3) and Evelyn Avenue (Reach E4). The solutions for preventing the bridges from overtopping are detailed here.

Caribbean Drive (Reach E1)

Caribbean Drive bridge is a dual-span bridge (three lanes in each direction) on piers over natural channel; it is located within the tidal zone. Under existing conditions, the bridge would be overtopped by about 2 feet of water during the design storm. HEC-RAS modeling has indicated that it may be possible to force the flow to go through the bridge as pressurized, and the project team is currently in the process of investigating different solutions for achieving this without having to rebuild the bridge (the gap between the two bridge spans would need to be sealed).

Duane Avenue (Reach E3)

Duane Avenue is a single-chamber, rectangular concrete box culvert with complex entrance characteristics. It has a fairly typical concrete wingwall entrance; however, the invert slope transitions abruptly at a distance of 5 feet upstream of the culvert entrance from 0.4% grade upstream to 40%. The invert slope then changes to 0.7% grade again from the culvert entrance. In addition, there is a 1.6 ft tall dragon's tooth/energy dissipation structure located at the 0.4%-40% slope transition. Because this entrance configuration was too complex to be adequately modeled with software, the project team hired a consultant [Multech Engineering] to construct a physical scale model of Duane Avenue, Culvert. The results of the physical scale model study were that the existing capacity of the culvert was smaller than the 100-year flow (796 cfs, or 94 cfs below the 890 cfs 100-year flow at Duane Avenue). The consultant was instructed to identify solutions for increasing the culvert capacity; findings were that the culvert entrance could be modified by a combination of removing the dragon's tooth structure and increasing the headwall height by at least 0.6 feet. Therefore, it would not be necessary to rebuild this culvert.

Wolfe Road (Reach E3)

Located immediately upstream of Duane Avenue culvert, the existing conditions HEC-RAS model showed that the dual-chamber concrete box culvert at Wolfe Road would overtop during a 100-year event. This was mainly due to the high tailwater downstream of Wolfe Road culvert. After the changes to the entrance of Duane Avenue culvert were implemented in the HEC-RAS model, the tailwater decreased, and Wolfe Road no longer overtopped.

Evelyn Avenue (Reach E4)

The existing conditions HEC-RAS model predicts a very small amount of overtopping at Evelyn Avenue, which is a single-chamber concrete box culvert. The project team conducted a modeling study to determine that overtopping of Evelyn Avenue culvert could be prevented by simply raising the headwall and apron leading to the culvert entrance at Evelyn Avenue by about 1 foot.

On Sunnyvale West Channel, there are two bridges which would overtop during the design storm: Carl Road and Caribbean Drive. Both are single-chamber concrete box culverts located within Reach W1 and the tidal zone. The project team assumes that Carl Road will need to be rebuilt as part of the project for a few reasons: 1) it is a one-lane road incapable of providing adequate access for emergency vehicles, 2) it overtops regularly during relatively small recurrence interval storms, and 3) it lacks capacity during the design storm. At Caribbean Drive, initial HEC-RAS modeling has indicated that increasing capacity could be achieved by raising the headwall and apron approaching the bridge. The project team will complete the designs of Carl Road and Caribbean Drive culvert in the design phase.

3.2 Erosion Problems

This section is split into two sub-sections. The first describes erosion sites identified by the project team which will be fixed as part of the project and the second describes the causes of erosion on the channel.

3.2.1 Erosion Sites

The project team has identified the locations and general sources of erosion problems along the channels. Identified erosion sites are generally either slumping failures, toe erosion, or scour near structures. These erosion problems have been determined based on analysis of the West Valley Watershed Field Inspection Reports (2004, 2006, and 2007), the geotechnical study performed by the SEW project team in 2007, and field visits by the team. As the extent of erosions along the channels is continually changing due channel flows and repairs by the watershed staff, the information in this section is considered preliminary. The exact locations and dimensions of the erosion locations will be finalized during the design phase of the project. The erosion sites identified to date are itemized in Tables 10 and 11 below.

Table 10. Erosion Sites along Sunnyvale East Channel

Reach	Location	Description	Erosion Repair Dimensions**	
			Length (ft)	Height (ft)
E6	Dunholme Way to Carlise Way	Slumping failure (5 to 6 ft high) on both banks	600	3
	Ashbourne Dr. to Fremont Ave.	Slumping failure on east bank	35	4
E5	Fremont Ave. to Crescent Ave.	Scour at transitions between hardscape and natural banks	20	5
	Crescent Ave. to El Camino Real	Slumping failure on both banks	600	5
E3	Kifer Rd. to Pedestrian Bridge	Sack-concrete failure on west bank	62	4
	Arques Ave. to Wolfe Rd.	Toe erosion and slumping failure on the west bank	450	6
	Wolfe Rd. to Duane Ave.	Slumping failure and toe erosion on both banks, in between hardscape	325	7
	Blythe Ave. to Hwy 101	Slumping failure on west bank	194	7
		Slumping failure on east bank	177	7
		Slumping failure on east bank	199	6
E2	Hwy 101 to Tasman Dr.	Slumping failure east bank at 3 locations along this 600-ft length	600	9
		Slumping failure on east bank, in between hardscape	70	9
	Tasman Dr. to Hwy 237	Toe erosion (3 ft high) on west bank	854	10

** These dimensions describe the along-channel length of repair (typically shorter than the entire length of the reach) and the height of the repair (up to the 10-year water surface elevation)

Table 11. Erosion Sites along Sunnyvale West Channel

All Alternatives: Erosion Protection on Sunnyvale West Channel				
Reach	Location	Description	Erosion Repair Dimensions**	
			Length (ft)	Height (ft)
W4	Parking Lot Culvert to Highway 101	Toe erosion (3 to 4 ft high) along outside bend of the east bank	210	5.23
	Highway 101 to Ross Dr.	Toe erosion (4 to 5 ft high) near gunny sack on east bank	50	4.30
		Minor slumping failure on west bank	30	4.95
W2	Mathilda Ave. to Bordeaux Dr.	Toe erosion on both banks	817	5.65
	Bordeaux Dr. to Java Dr.	Toe erosion and slumping failure on both banks	1872	6.15
	Java Dr. to Caribbean Dr.	Toe erosion and slumping failure on both banks	1852	6.77
W1	Caribbean Dr. to Carl Rd.	Toe erosion and slumping failure on west bank	300	7.05
** These dimensions describe the along-channel length of repair (typically shorter than the entire length of the reach) and the height of the repair (up to the 10-year water surface elevation)				

3.2.2 Causes of Erosion

Erosion problems along SEW Channels are pervasive and include historic invert erosion, localized scour, slumping failures, toe erosion, and undermining of hardscape features. They present a significant maintenance issue for the District because the erosion problems frequently threaten structures located adjacent to the top of the channel banks; i.e., the channel lacks sufficient floodplain.

The project team has identified several main causes of erosion problems along the two channels, as detailed here. Each of the erosion sites identified by the project team may be due to one or more of these causes.

- Lack of an upstream sediment supply. As discussed in Section 2.2.2, the channels tie into the City of Sunnyvale's storm drain system on their upstream ends, which supply little sediment to the downstream reaches. This has led to historic invert erosion in the upstream reaches of both channels; the channel invert now appears to be relatively stable.

- Insufficient floodplain or right-of-way corridor. This prevents the constructed channels from naturally evolving to a stable, geomorphic geometry.
- Intermittent hardscape and natural reaches of channel. Largely due to the existing narrow right-of-way corridor, the District has repaired bank erosion at many locations by lining the channels with sacked concrete, rip-rap, or concrete in areas where structures or property is threatened by erosion. This has led to reaches of channel with intermittent sections of hardscape and natural channel, leaving natural channel reaches particularly subject to further erosion problems. In addition, the hardscape-lined reaches of channel themselves have required maintenance.
- Multiple road crossings. Sunnyvale East Channel has 22 road and pedestrian bridge crossings and pedestrian bridges combined, all but three of which are concrete culverts. Many of these are hydraulically steep (i.e., are capable of inducing supercritical flow) and contain drop structures, which creates the potential for local scour and deposition (e.g., upstream and downstream of a hydraulic jump). Sunnyvale West Channel has 8 road crossings; one of these is a long, hydraulically steep culvert which results in scour downstream.
- Constructed channel bends. The bends on both channels were not well designed and are experiencing severe (5-6 feet) of vertical erosion along the outer banks.
- Insufficient transition lengths between trapezoidal- and rectangular- shaped sections of channel.
- The observed 2-3 feet of consistent toe erosion in tidal reaches on both channels may be due in part to the channels original design. With a trapezoidal cross section, which did not provide a geomorphic, bankfull channel for the tidal flows these reaches receive on a regular basis.
- Hydromodification of the watershed area due to urbanization and land development. For storms of the same recurrence interval, urbanization and land development decrease the watershed’s time of concentration and increase the peak flow rates.
- Repeated high-velocity storms due to watershed land development, densification, and hydromodification.

3.3 Sedimentation Problems

Sedimentation problems exist along the channels, have required sediment removal in the past, and are generally due to either the sedimentation of bay mud in tidal reaches or to local sedimentation downstream of storm drains. Sedimentation problems requiring sediment removal have occurred primarily in the tidal reaches of Sunnyvale East Channel and secondarily in the tidal reaches of Sunnyvale West Channel. There are also less problematic sedimentation sites located out of the tidal zone and downstream of several culverts on Sunnyvale East Channel, most notably Highway 101.

3.4 Sea Level Rise

Modeling the effects of climate change on sea level rise is a complicated and evolving process. Many reputable government agencies and organizations, such as the US Army Corps of Engineers (the Corps), the National Research Council, the Intergovernmental Panel on Climate Change (IPCC), and the Pacific Institute, are currently studying the effects of climate change due to global warming. A list of the sea level rise projections from these and other agencies entitled “Projections of Future Sea Level Rise,” was obtained from the District’s Office of Stewardship Planning. This list includes projections from 34 separate studies, all with varying results. For example, for the year 2050, low estimates of sea level rise range from 2.4 inches to 11.8 inches, and high estimates range from 12.0 inches to 23.6 inches.

Although there is still great uncertainty associated with sea level rise, the project team investigated the possible future impacts of sea level rise to its proposed alternatives. The team employed the high sea level rise estimate from the Corps, 2 feet by 2050, for this analysis. This value was chosen because it is being used for the South San Francisco Bay Shoreline Study, whose study area encompasses the tidally-influenced areas of the SEW Project, and because it is the more conservative than the Corps low value of 6-inches.

For analysis of the alternatives which do not include realignment of the channels (B and D), the downstream starting water surface elevations used by the project team were generated with an unsteady HEC-RAS hydraulic model which models the network of channels which empty to Guadalupe Slough; see Chapter 2 for more details on how the channels interact. This model was run for the following storm scenario: 100-year hydrographs on all channels contributing to the network and a 10-year tide at the downstream boundary condition. In order to determine the effects of sea level rise on this system, the project team added 2 feet to the 10-year tidal elevation time series and re-ran the model. The result of this analysis was that there was an insignificant change of about 0.1 feet to the starting water surface elevation, assuming that the levees along each channel would hold. The reason for the small difference is that the backwater flows from Calabazas and San Tomas Aquino creeks during the extreme simulated storm have a larger effect on downstream water surface elevations for the SEW Channels than would the downstream tidal elevations.

For alternatives which realign the channels to flow into Pond A4 (H, I, J, and K), the project team designed the Pond A4 element to provide adequate inboard and outboard freeboard in the event of 2 feet of sea level rise. The levees around Pond A4 would be built high enough to prevent overtopping from a 100-year tide with two feet of sea level rise. In addition, the project team conducted modeling studies to ensure that the proposed vertical positioning of the flap gates would allow the pond to drain stored flows from simultaneous 100-year flow events on the SEW channels within 72-hours while still providing at least 1 ft of inboard freeboard. This study was necessary because, in the event of sea level rise, the low tide would also rise by 2 feet and could potentially impede the draining of the pond.

4 PROJECT OUTREACH

One of the most important aspects of the planning process is the identification and participation of the interested parties within the project area. Interested parties include individuals, agencies, and organizations which may affect or be affected by the SEW Project. These entities may have a vested interest in the goals, activities, implementation and outcomes of the project. The success of the project depends on the collaboration of these identified parties. Involving interested parties:

- Facilitates better decisions and better implementation of decisions;
- Facilitates buy-in and support for the project;
- Allows interested parties greater ownership of the project;
- Guards against the project becoming too inwardly focused and aids decentralized decision making; and
- Helps to identify issues not addressed by the project staff.

The majority of the stakeholder(s) will be those affected by the project and those interested in possible impacts to the site from an environmental or regulatory nature. Throughout the planning process, outreach activities have been carried out to inform the public of project progress and solicit public feedback. Several public meetings were held at milestones along the planning process. Finally, specific outreach activities have been conducted with local groups and resource agencies.

The project will also hold public meetings as required by the California Environmental Quality Act. Other outreach efforts will be aimed at the appropriate regulators and environmental resource groups. The SEW Project will continue to include outreach to the residential, commercial, and industrial districts within the SEW Project area during the design and construction phases of this project.

4.1 Outreach to Public

The project team conducted outreach with the public at various project milestones through flyers, surveys, and public meetings. Outreach materials were sent to property owners living adjacent to the channels or in the SEW Channels' one-percent floodplain.

- ***Geotechnical Field Work (May, 2007):*** mailed a flyer to approximately 3,000 residents adjacent to the Channels notifying them about the geotechnical field work being performed in their area.

- ***Historical Flooding (October, 2007):*** mailed survey to approximately 3,000 residents adjacent to the channel requesting information about historical flooding in the area.

- ***Conceptual Alternative Meeting (March, 2009):*** discussed the conceptual alternatives with the public and solicited their feedback.

- ***Natural Flood Protection (May, 2009):*** mailed survey to approximately 6,000 residents adjacent to the channel asking residents to rank the nine criteria to be used to evaluate the feasible alternatives.

- ***Neighborhood Update (June, 2009):*** mailed out a flyer with project updates and results from the natural flood protection survey.

- ***Feasible Alternative Meeting (November, 2009):*** discussed the feasible alternatives (including NFP process) with the public and solicited their feedback.

4.2 Outreach to Public Agencies

As the planning process progressed, meetings were held with various affected local jurisdictions. These meetings were opportunities to discuss potential project benefits and impacts with the cities, school district, and water pollution control plant and collect early feedback and comments.

- City of Sunnyvale Staff (February, 2009)
- City of Sunnyvale Staff (November, 2009)
- Coordination meeting with City of Sunnyvale, Lockheed-Martin, NASA, and USFWS Staff (January, 2010)
- Santa Clara Unified School District – Braly Elementary School and Facility Staff (January, 2010)
- City of Sunnyvale - Water Control Plant Staff (WPCP) (March, 2010)
- Santa Clara Unified School District - Board Meeting (February, 2010)
- City of Sunnyvale - City Council Meeting (April, 2010)

Further outreach will continue, culminating in the official CEQA process.

4.3 Outreach to Regulatory Agencies

The project will require permits and consultation from several regulatory agencies including the United States Fish and Wildlife Service, the Army Corps of Engineers, the California Department of Fish and Game, the Regional Water Quality Control Board and the San Francisco Bay Conservation and Development Commission. The project team provided the regulatory agencies with summaries of the conceptual and feasible alternatives reports in order to show the project progress and seek input on the analysis. This was followed up by an onsite meeting with the resource agencies in March 2010 to show the site conditions at various locations in the project footprint, including Guadalupe Slough and Pond A4. Issues brought up on that site visit that will require subsequent discussion and evaluation include the conversion of salt marsh habitat, potential impacts to sensitive and fully protected species such as the salt marsh harvest mouse and California clapper rail and potential impacts to water quality in Guadalupe Slough from construction activities and alternation of the existing hydraulic regime. As the project moves forward, additional outreach to regulatory agency staff will be conducted to ensure issues are evaluated in the design phase.

4.4 Outreach to Watershed Stakeholders

The project team has conducted outreach with various environmental and civic stakeholders in the project area. This effort was undertaken to inform the stakeholders of the project and its progress and to solicit early feedback.

- Sunnyvale Chamber of Commerce (September, 2008)
- Sunnyvale Bicycle and Pedestrian Advisory Commission (April, 2009)

5 FORMULATION AND EVALUATION OF ALTERNATIVES

The District's planning process generally has three stages: development of conceptual alternatives, development of feasible alternatives and finally the development of a staff-recommended alternative. This chapter provides details on the alternatives developed in these processes and documents the evaluation used to select the staff-recommended project.

5.1 Conceptual Alternatives

During the conceptual alternative planning stage, numerous approaches to meet the project objectives were identified. Each of these approaches is referred to as a *Conceptual Project Element* (CPE). The following CPEs were developed during the conceptual stage and then were refined during the feasible stage.

1. No Project
   Under this CPE, the channels would remain in their existing conditions. Flood flows would continue to overtop channel banks and inundate adjacent properties and current FEMA insurance requirements in the area would continue. Current maintenance activities to remove sediment, repair erosion, and maintain vegetation would continue.

2. Floodwalls
   This CPE would provide flood protection by creating a concrete barrier that would contain flow within the channel thereby increasing overall channel capacity. The floodwalls would be constructed on the outboard side of the channels and would be placed at a minimum distance of 15 feet from the inboard top of bank to provide adequate access for maintenance activities. An example of the existing condition (left) and the proposed condition with floodwalls (right) can be seen in Figure 16.

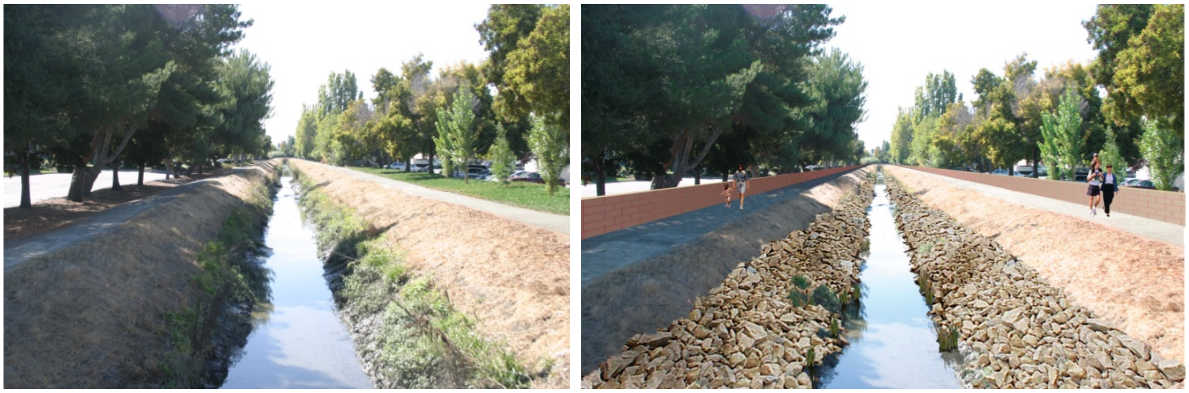

Figure 16. Floodwall Example (Sunnyvale West Channel at Java Drive)

3. Levees
   This CPE would provide flood protection by creating new or raising existing levees (earthen barriers that contain flow within the channel) thereby increasing the overall channel capacity. Levees would be designed with 2:1 (H:V) side slopes and a minimum top width of 15 feet. An example of the existing condition with levees (left) and the proposed condition with levees raised (right) can be seen in Figure 17.

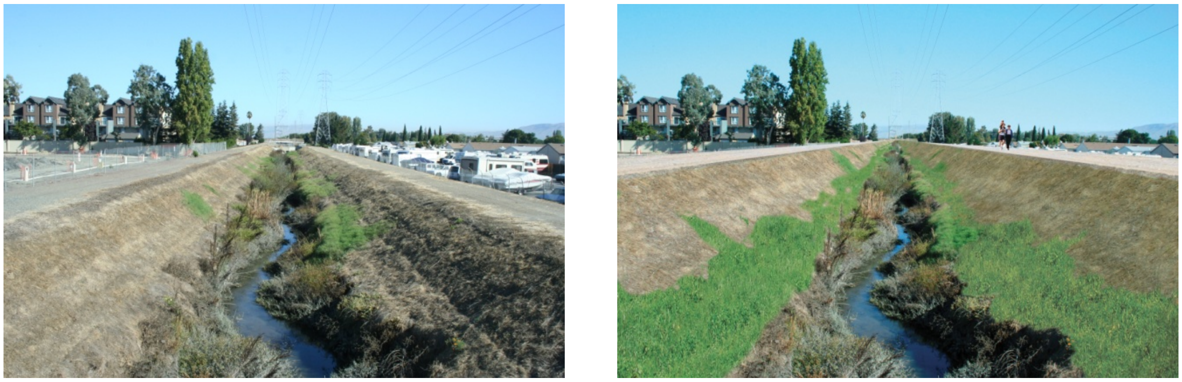

Figure 17. Levee Example (Sunnyvale East Channel at Tasman Drive)

4. Detention Area
   This CPE would provide flood protection by diverting high flows during a flood event into a below ground detention area and temporarily storing them until the flooding period is over. The detention area would be created along Sunnyvale East Channel at Braly Park, which is owned by the city of Sunnyvale. The detention area would be 4 acres in area and approximately 8 feet in depth, with mild side slopes of 3:1 (H:V). The existing tennis court and playground structures would be re-built at the new field level. The footprint of the proposed detention area can be seen in Figure 18. The detention area would be sloped from the outer to the inner blue boundary line.

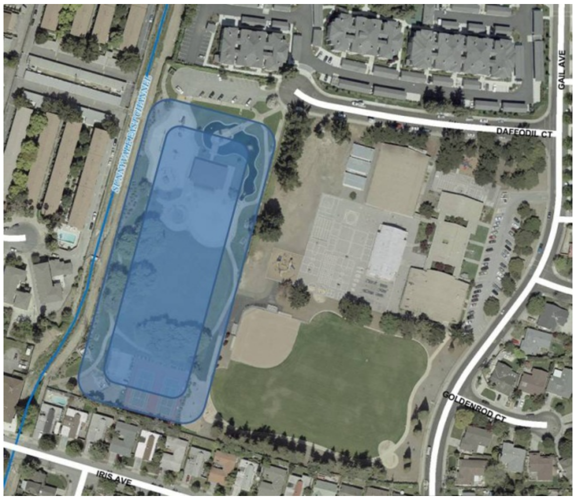

Figure 18. Braly Park Detention Area

During a storm event, flows higher than approximately the seven-year event would spill over a weir and into an energy dissipation area. The detention area would then fill with water over a short period. The detention area would be designed to drain stored flood flows by gravity within 1-2 days after flood waters have receded in the channel, depending on the size of the flood event. The fields and facilities would then be cleaned and prepared for public use. During the 100-year flood event, this detention area would fill over a 3 hour period and reduce the downstream peak flow rate by approximately 240 cfs (from a peak flow rate of 740 cfs to 500 cfs).

There are no suitable areas along Sunnyvale West Channel for offstream detention.

5. Box Culvert
   This CPE would provide flood protection by replacing the existing open channel in areas with insufficient 100-year storm capacity or freeboard with a buried, concrete box culvert designed to contain the 100-year flow. This CPE would both improve the existing channel flow capacity and eliminate erosion problems by replacing erodible earthen channels with a concrete box culvert. This CPE was not considered feasible because of the high cost and was not moved forward from the conceptual phase of the project.

6. Erosion Protection
   This CPE would provide erosion protection and bank stability by using a rock toe and earth fill protection method, suitable for the steep-banked (1.5:1, H:V) trapezoidal channel cross section found along Sunnyvale East and West Channels. This method entails placing a layer of rock along and beneath the channel bottom and banks extending up to the 10-year flow level in non-tidal reaches and up to the mean higher high water level in tidal reaches. Above this level, the banks would be re-graded, filled with earth (if needed), covered with erosion control fabric, and hydro-seeded to establish a protective layer of vegetation. An example of rock toe and earth fill protection can be seen in Figure 36.

7. Pond A4
   This CPE would provide flood protection by removing the channels from tidal influence and backwater effects from large flows on Guadalupe Slough due to inputs from San Tomas Aquino and Calabazas Creek, thereby lowering the downstream water level during storms and reducing the height of flood protection needed. Construction of this element would involve realigning both channels to flow into Pond A4, installing tide gates and a slide gate along the existing levee between Pond A4 and Guadalupe Slough, and raising portions of the levees around the pond to provide adequate freeboard (Figure 19). This would convert Pond A4 from a managed open water pond with no interaction with the channels and slough which surround it, to a detention basin which would temporarily store flows from the channels and release them to Guadalupe Slough during low tides.

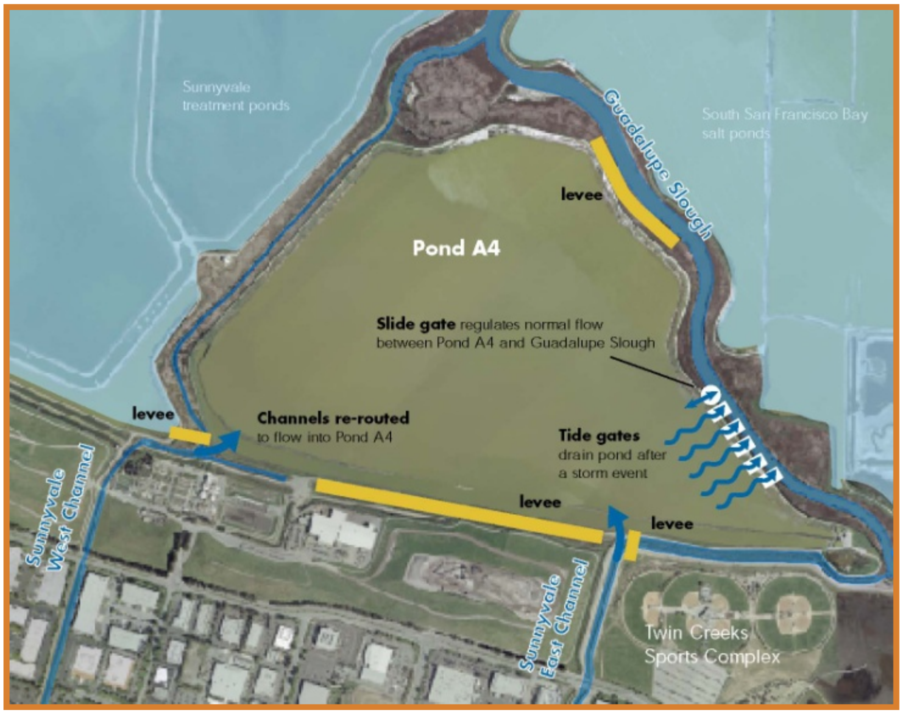
Sunnyvale treatment ponds
Guadalupe Slough
South San Francisco Bay salt ponds
levee
Pond A4
Slide gate regulates normal flow between Pond A4 and Guadalupe Slough
levee
Channels re-routed to flow into Pond A4
Tide gates drain pond after a storm event
levee
levee
Sunnyvale West Channel
Sunnyvale East Channel
Twin Creeks Sports Complex

Figure 19. Pond A4 Converted to a Detention Basin

The construction of any single CPE would not meet the project objectives. Therefore, each conceptual alternative was composed of several CPE's used in combination to meet the project objectives.

Fourteen alternatives were developed and analyzed in the conceptual phase of the project, as shown in Table 12.

Table 12. Conceptual Alternatives

Alternative		Conceptual Project Elements (CPE's)					
		Floodwalls	Levees	Box Culvert	Detention Area	Pond A4 Detention Basin	Erosion Protection
A	No Project						
B	Floodwalls, Erosion Protection	X					X
C	Levees, Erosion Protection		X				X
D	Floodwalls, Detention, Erosion Protection	X			X		X
E	Levees, Detention, Erosion Protection		X		X		X
F	Box Culvert, Floodwalls, Erosion Protection	X		X			X
G	Box Culvert, Levees, Erosion Protection		X	X			X
H	Floodwalls, Pond A4, Erosion Protection	X				X	X
I	Levees, Pond A4, Erosion Protection		X			X	X
J	Floodwalls, Detention, Pond A4, Erosion Protection	X			X	X	X
K	Levees, Detention, Pond A4, Erosion Protection		X		X	X	X

The project goals and cost were used as evaluation criteria. To allow for evaluation of a full range of alternatives, the cost criteria was set at $55.5 million (1.5 times the project budget). Alternatives C, E, F, and G were eliminated for failure to meet the cost criteria, whereas Alternatives A, B, D, H, I, J, K met all criteria were moved forward to the feasible planning phase for development and analysis (SCVWD 2009). Descriptions of each of the alternatives to be carried forward for feasible analysis can be found in the next section of the report.

5.2 Feasible Alternatives Description

The purpose of this section is to provide descriptions of each of the feasible alternatives. At the end of this section, Table 13 provides a summary comparison of the alternatives.

5.2.1 Alternative A: No Project

Alternative Description

Under feasible alternative A, no new project elements would be implemented in the study area. Flood flows would continue to overtop channel banks and inundate adjacent properties, resulting in flood-related damages to residences and businesses (Figure 15). Current maintenance activities such as sediment removal, erosion repair, and vegetation maintenance would continue.

5.2.2 Alternative B: Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality (Figure 20). Floodwalls are used to provide flood protection south of the San Francisco Bay shoreline and levees are used north of Carl Road along Sunnyvale West Channel and along the Pond A4 boundary on Sunnyvale East Channel to better blend with the surrounding landscape. This is a change from the conceptual planning stage, where floodwalls continued north of Carl Road.

Along Sunnyvale East Channel, average floodwall/levee heights range from 2.5 to 4.5 feet in the following locations: near Evelyn Avenue, Blythe Avenue and south of Highway 101, between Wolfe Road and Duane Avenue, and north of Highway 101 to the confluence with Guadalupe Slough.

Along Sunnyvale West Channel average floodwall heights range from 0.5 to 4.5 feet from Mathilda Avenue to Carl Road and existing levees are raised from 0.5 to 3.0 feet from Carl Road to the confluence with Guadalupe Slough.

Erosion protection is provided by installing a protective rock layer to the 10-year mean higher high water elevation and using erosion control fabric and native vegetation to protect the channel banks. Erosion protection is the same for all alternatives.

Details for this alternative are provided in Appendix A.

Operation and Maintenance

Under Alternative B, maintenance activities along the channels, such as trash and debris removal, mowing vegetation on channel banks, and sediment removal, would be the same as under the existing condition. Work needed to repair erosion sites would decrease initially as most of the existing erosion locations would be repaired.

New maintenance due to the construction of Alternative B would be limited to increased graffiti removal due to the installation of new floodwalls.

Land Ownership/Access

It is expected that strips of land from 9 parcels on Sunnyvale East Channel and 12 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative B. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$39,500,000
Land Acquisition:	$ 8,000,000
50 Yr Maintenance:	$ 2,900,000
Total Lifetime Cost:	$50,400,000

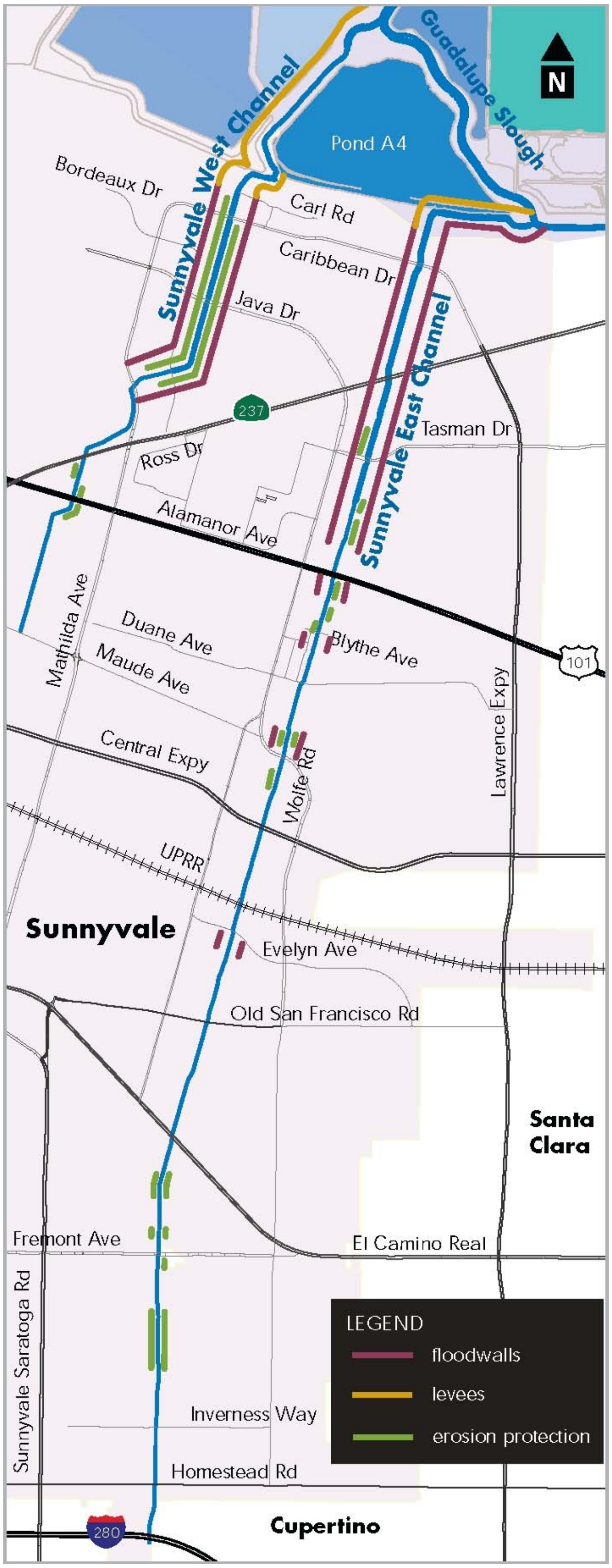

Figure 20. Feasible Alternative B: Floodwalls, Levees, and Erosion Protection

5.2.3 Alternative D: Detention Area, Floodwalls, and Erosion Protection

Alternative Description

This alternative combines detention at Braly Park, floodwalls, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality (Figure 21).

For Sunnyvale East Channel, this alternative is similar to Alternative B; however, the use of Braly Park for detention eliminates the need for additional flood protection elements (for example floodwalls or levees) south of Highway 101 and slightly reduces the average floodwall/levee heights range from 2.5 to 4.5 feet to 2.0 to 4.5 feet north of Highway 101 to the confluence with Guadalupe Slough**.**

There is not a suitable location for detention along Sunnyvale West Channel, therefore for this alternative floodwall locations are the same as Alternative B.

Details for this alternative are provided Appendix A.

Operation and Maintenance

Under Alternative D, maintenance activities along the channels, such as trash and debris removal, mowing vegetation on channel banks, and sediment removal, would be the same as under the existing condition. Work needed to repair erosion sites would decrease initially as most of the existing erosion locations would be repaired.

Alternative D would require increased graffiti removal due to the installation of new floodwalls. In addition, the detention area at Braly Park would require event-driven maintenance of the inlet and outlet, clearing of silt and other flood debris from the facility, and restoration of the playing surfaces (dirt areas, chalk lines, etc.).

Land Ownership/Access

It is expected that strips of land from 2 parcels on Sunnyvale East Channel and 12 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative D. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$42,700,000
Land Acquisition:	$ 6,800,000
50 Yr Maintenance:	$ 2,500,000
Total Lifetime Cost:	$52,000,000

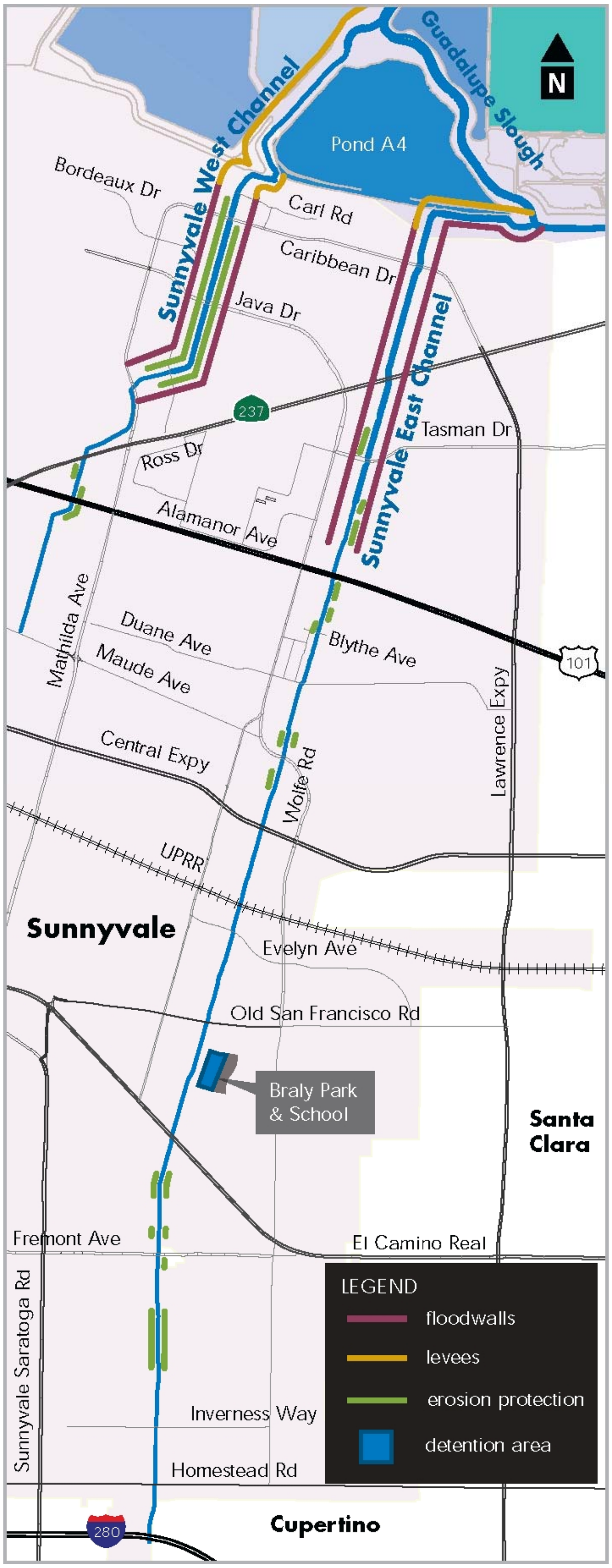

Figure 21. Feasible Alternative D – Detention, Floodwalls, Levees, and Erosion Protection

5.2.4 Alternative H: Pond A4, Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines Pond A4, floodwalls, levees and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 22).

The locations of the floodwalls and levees along Sunnyvale East are similar to Alternative B; however rerouting the channels into Pond A4 reduces the height required. The average floodwall/levee heights range from 1.5 to 4.5 feet near Evelyn Avenue, Blythe Avenue and south of Highway 101, between Wolfe Road and Duane Avenue, and north of Highway 101 to the new connection with Pond A4**.**

Along Sunnyvale West Channel, rerouting the channel into Pond A4 reduces the height of floodwalls/levees from Mathilda Avenue to Carl Road to an average of 1.0 to 3.5 feet. Details for this alternative are provided in Appendix A.

Operation & Maintenance

Under Alternative H, maintenance activities along the channels, such as trash and debris removal and mowing vegetation on channel banks, would be the same as under the existing condition. Work needed to repair erosion sites would decrease initially as most of the existing erosion locations would be repaired and sediment removal work would be reduced or eliminated due to rerouting the channels into Pond A4.

Alternative H would require increased graffiti removal due to the installation of new floodwalls. Utilizing Pond A4 as a detention basin would require routine and event-driven maintenance. Regular maintenance of the inlets, slide gate, and tide gates would be required to prevent erosion and deposition problems. Before predicted storm events, the slide gate between Pond A4 and Guadalupe Slough would need to be closed to disconnect the pond from Guadalupe Slough and allow the pond to fill with storm water. The slide gate would be opened again after the accumulated stormwater had been drained from the pond. It is expected that the maintenance costs for Pond A4 would increase due to maintenance of the inlet and outlet structures.

Land Ownership/Access

It is expected that strips of land from 9 parcels on Sunnyvale East Channel and 7 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative H. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$35,400,000
Land Acquisition:	$ 7,300,000
50 Yr Maintenance:	$ 7,300,000
Total Lifetime Cost:	$50,000,000

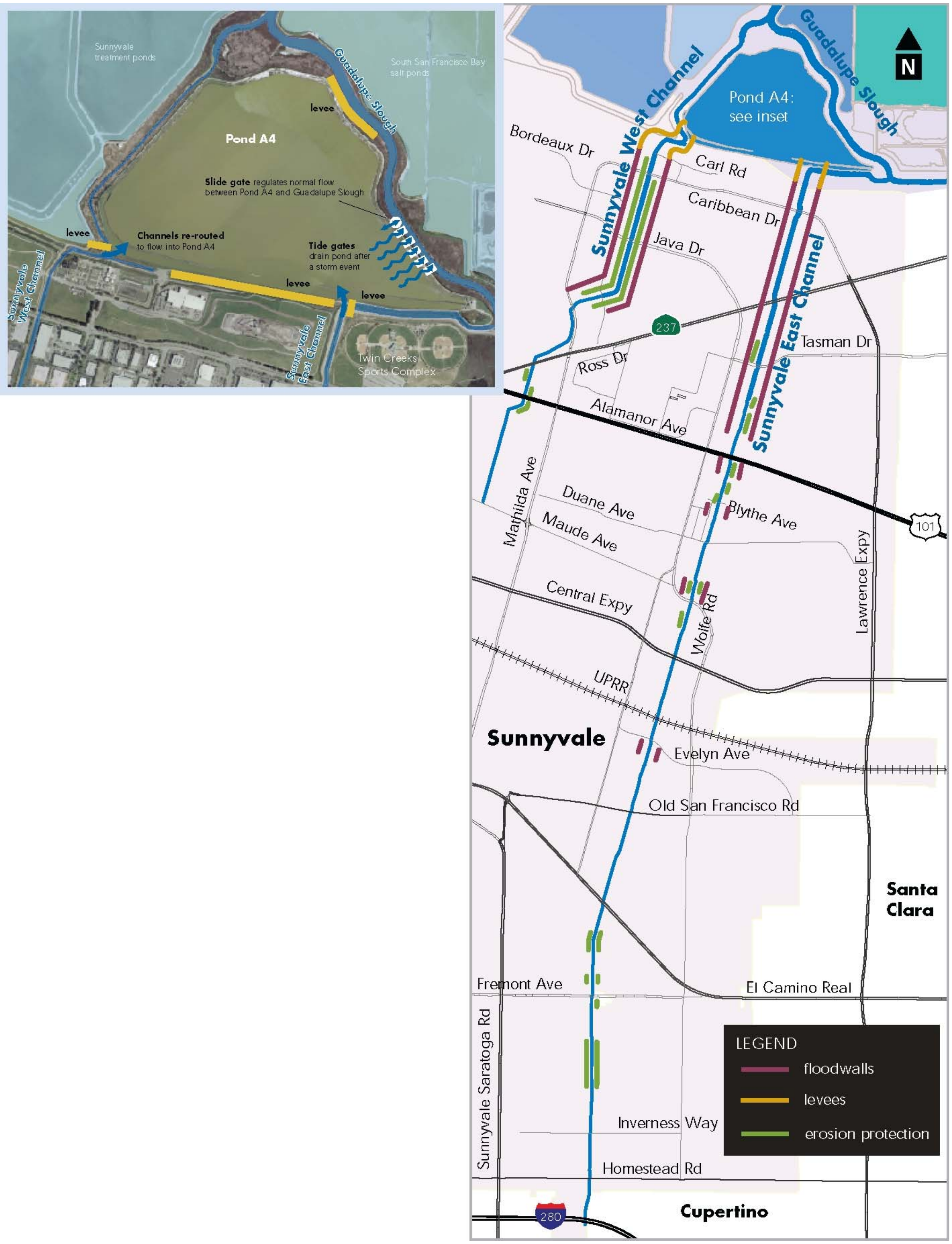

Figure 22. Feasible Alternative H – Pond A4, Floodwalls, Levees and Erosion Protection

5.2.5 Alternative I: Pond A4, Levees, and Erosion Protection

Alternative Description

This alternative combines Pond A4, levees, and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 23).

The locations and heights of the levees along the channels are the same as the locations of the floodwalls described in Alternative H.

Details for this alternative are provided in Appendix A.

Operation & Maintenance

Trash, debris, and graffiti removal costs would be equivalent to the existing condition.

Mowing costs would increase due to the increased height, and therefore area, of levees to be mowed. Sediment removal work would be reduced or eliminated due to rerouting the channels into Pond A4. Operation of Pond A4 would be the same as Alternative H.

Land Ownership/Access

Alternative I requires the most land acquisition of all the alternatives. It is expected that strips of land from 22 parcels on Sunnyvale East Channel would need to be acquired by the District in fee or easement for the construction of Alternative I. This would result in impacts to approximately 60 homes along Sunnyvale East Channel. Along Sunnyvale West Channel, 21 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative I.

Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$19,400,000
Land Acquisition:	$31,300,000
50 Yr Maintenance:	$ 4,900,000
Total Lifetime Cost:	$55,600,000

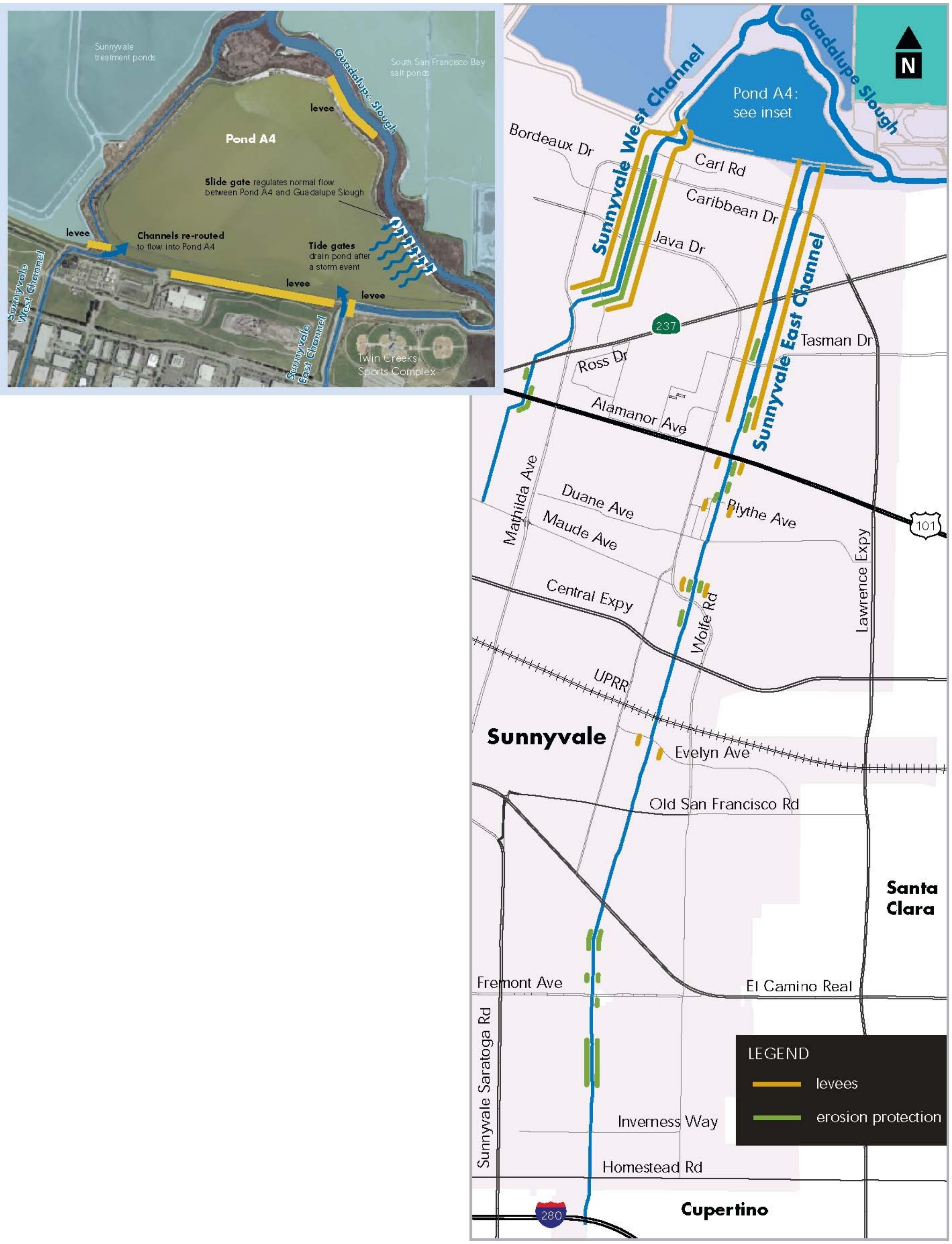

Figure 23. Feasible Alternative I – Pond A4, Levees, and Erosion Protection

5.2.6 Alternative J: Pond A4, Detention Area, Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines Pond A4, detention, floodwalls, levees and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 24). This alternative requires the shortest height and length of floodwalls due to the lower downstream water surface elevations from re-routing the channels to Pond A4 and the resultant smaller flows during large events downstream of the detention area at Braly Park.

Along Sunnyvale East Channel, average floodwall heights range from 1.5 to 3.5 feet north of Highway 101 to the confluence with Guadalupe Slough the new connection with Pond A4**.**

Floodwalls along Sunnyvale West Channel from Mathilda Avenue to Carl Road, average from 1.0 to 3.5 feet.

Details for this alternative are provided in Appendix A.

Operation & Maintenance

Trash, debris, and sediment removal and vegetation mowing costs would be equivalent to the existing condition.

Graffiti removal would be similar to Alternative D, due to the elimination of floodwalls south of Highway 101. Sediment removal would be reduced or eliminated due to rerouting the channels into Pond A4. Operation and maintenance of Braly Park detention would be the same as described under Alternative D. Operation and maintenance of Pond A4 would be the same as described under Alternative H.

Land Ownership/Access

Alternative J requires the least amount of land acquisition. It is expected that strips of land from 2 parcels on Sunnyvale East Channel and 7 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative J. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$ 38,700,000
Land Acquisition:	$ 6,200,000
50 Yr Maintenance:	$ 6,800,000
Total Lifetime Cost:	$ 51,700,000

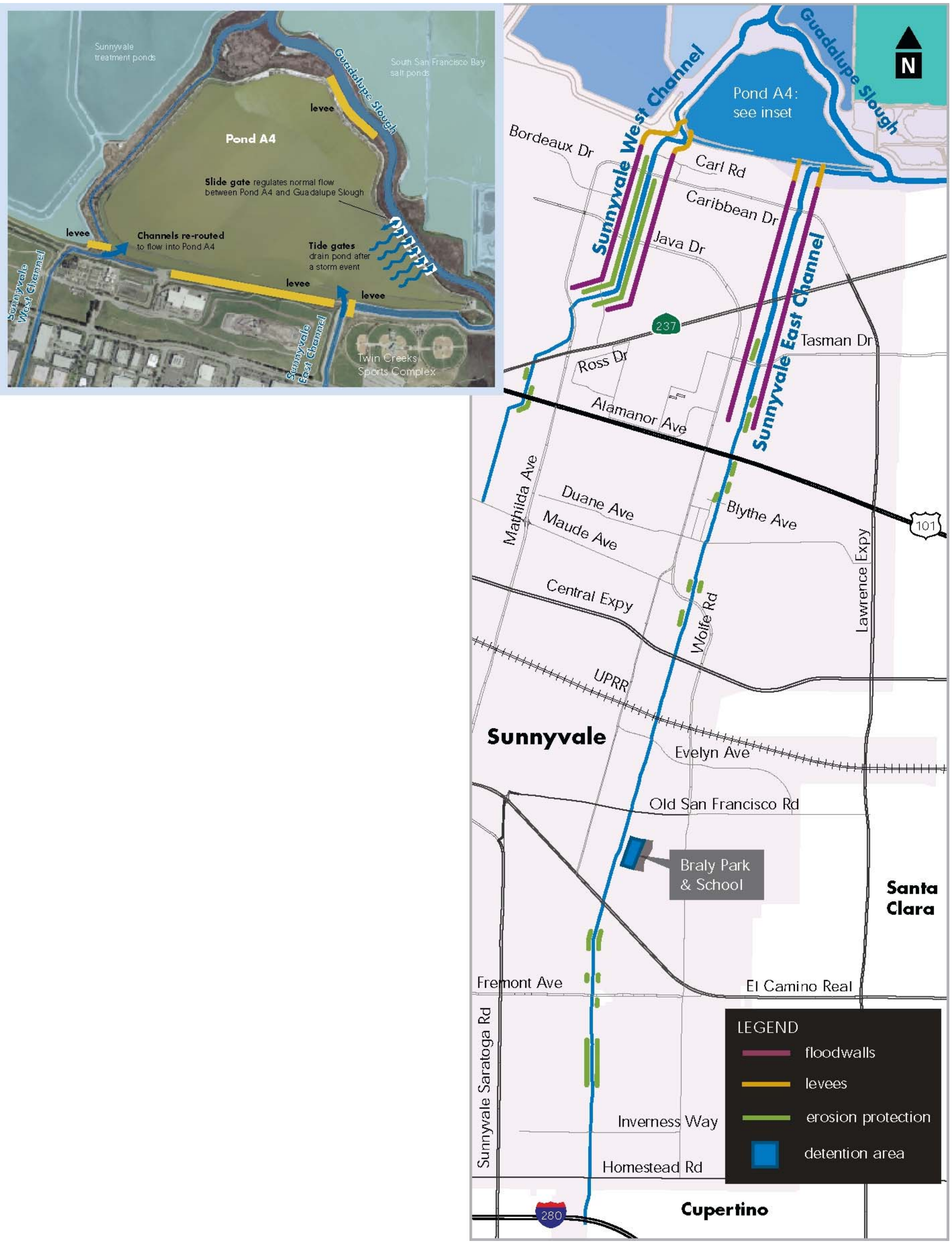

Figure 24. Feasible Alternative J – Pond A4, Detention, Floodwalls, and Erosion Protection

5.2.7 Alternative K: Pond A4, Detention Area, Levees, and Erosion Protection

Alternative Description

This alternative combines Pond A4, detention, levees, and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 25).

The locations and heights of the levees along the channels are the same as the location of the floodwalls in described Alternative J.

Details for this alternative are provided in Appendix A.

Operation & Maintenance

Trash, debris, and graffiti removal costs would be equivalent to the existing condition.

Mowing costs would increase due to the increase height, and therefore area, of levees to be mowed. Sediment removal work would also be reduced or eliminated due to rerouting the channels into Pond A4. Operation and maintenance of Braly Park detention would be the same as described under Alternative D. Operation and maintenance of Pond A4 would be the same as described under Alternative H.

Land Ownership/Access

It is expected that strips of land from 11 parcels on Sunnyvale East Channel would need to be acquired by the District in fee or easement for the construction of Alternative K. This would result in impacts to approximately 57 homes along Sunnyvale East Channel. Along Sunnyvale West Channel 21 parcels would need to be acquired by the District in fee or easement for the construction of Alternative K. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$ 24,900,000
Land Acquisition:	$ 25,600,000
50 Yr Maintenance:	$ 5,500,000
Total Lifetime Cost:	$ 56,000,000

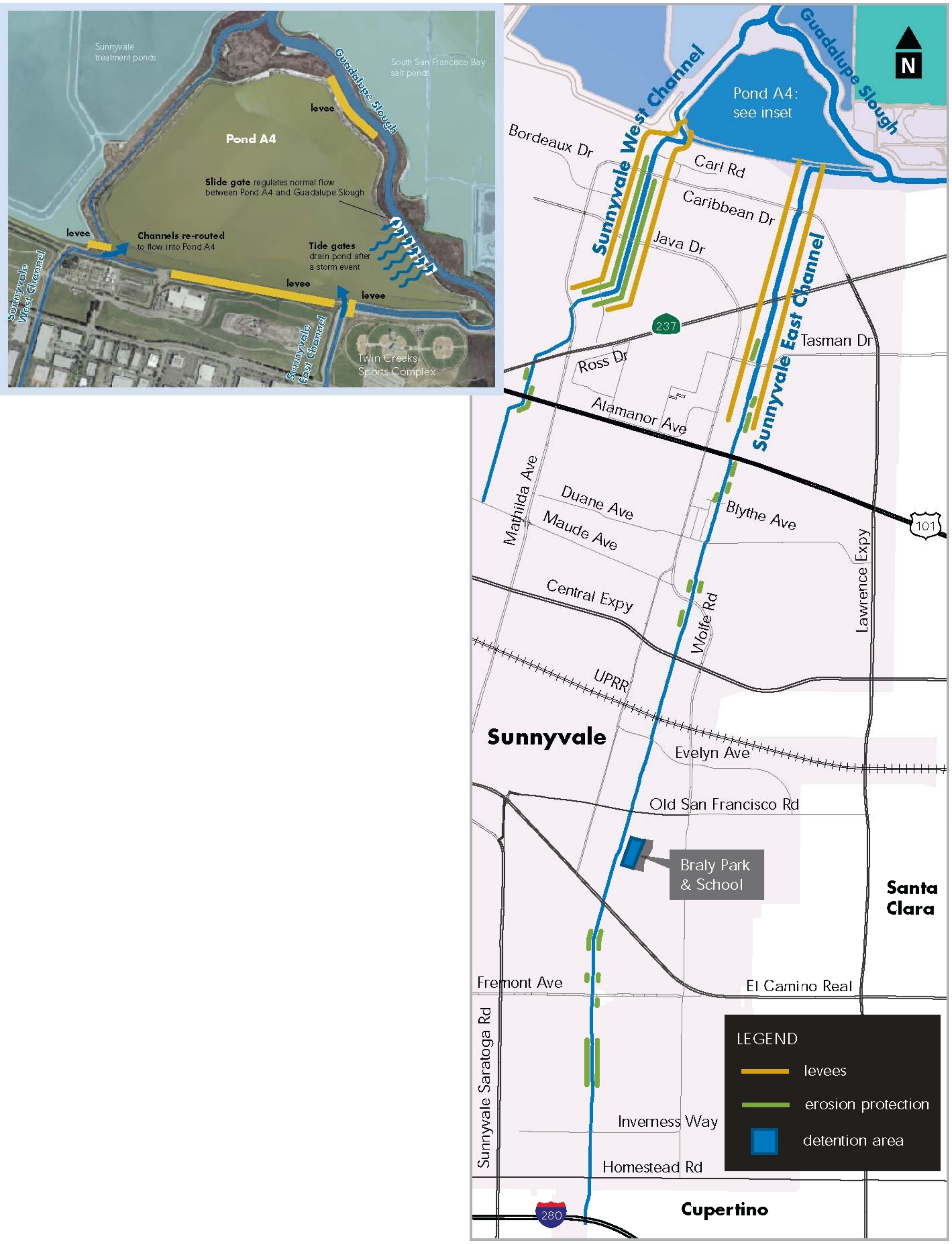

Figure 25. Feasible Alternative K – Pond A4, Detention, Levees, and Erosion Protection

Table 13. Feasible Alternatives Summary

		Alt B	Alt D	Alt H	Alt I	Alt J	Alt K
Sunnyvale East Channel	Floodwalls	2.5 - 4.5 ft high	2 - 4.5 ft high	1.5 - 4.5 ft high	No Floodwalls	1.5 - 3.5 ft high	No Floodwalls
		for 2 mi	for 1.7 mi	for 1.5 mi		for 1.4 mi	
	Levees	Raise Pond A4 levee by 4.5 ft for 0.5 mi	Raise Pond A4 levee by 4.5 ft for 0.5 mi	No Levees	1.5 - 4.5 ft high	No Levees	1.5 - 3.5 ft high
					for 1.5		for 1.4
Sunnyvale West Channel	Floodwalls	0.5 - 4.5 ft high	0.5 - 4.5 ft high	1 - 3.5 ft high	No Floodwalls	1 - 3.5 ft high	No Floodwalls
		for 1 mi	for 1 mi	for 1 mi		for 1 mi	
	Levees	0.5 - 3 ft high	0.5 - 4.5 ft high	2 ft high	1 - 3.5 ft high	2 ft high	1 - 3.5 ft high
		for 3/4 mi	for 3/4 mi	for 0.2 mi	for 1 mi	for 0.2 mi	for 1 mi
Land Acquisition	Residential/Commercial Parcels	9/12	2/12	9/7	22/21	2/7	11/21
	# of homes	No homes taken	No homes taken	No homes taken	60 homes taken along sunnyvale East Channel	No homes taken	57 homes taken along sunnyvale East Channel
Detention			X			X	X
Pond A4				X	X	X	X
New Operations and Maintenance Activities				Reduced Sediment Removal In Channels	Reduced Sediment Removal In Channels	Reduced Sediment Removal In Channels	Reduced Sediment Removal In Channels
		Additional Graffiti Removal	Additional Graffiti Removal	Additional Graffiti Removal		Additional Graffiti Removal	
			Cleaning Braly Park (after large storms, every 7-8 years)			Cleaning Braly Park (after large storms, every 7-8 years)	Cleaning Braly Park (after large storms, every 7-8 years)
				Operating Slide Gate on Pond A4 Before and After Storms	Operating Slide Gate on Pond A4 Before and After Storms	Operating Slide Gate on Pond A4 Before and After Storms	Operating Slide Gate on Pond A4 Before and After Storms
				Maintenance of Inlets, Tide Gates, and Slide Gate	Maintenance of Inlets, Tide Gates, and Slide Gate	Maintenance of Inlets, Tide Gates, and Slide Gate	Maintenance of Inlets, Tide Gates, and Slide Gate
				Sediment Removal from Outlet Channel in Guadalupe Slough	Sediment Removal from Outlet Channel in Guadalupe Slough	Sediment Removal from Outlet Channel in Guadalupe Slough	Sediment Removal from Outlet Channel in Guadalupe Slough
O&M Cost	Annually	$20,000	$17,000	$50,000	$34,000	$47,000	$38,000
	Over 50 yrs	$2.9 Million	$2.5 Million	$7.3 Million	$4.9 million	$6.8 Million	$5.5 Million
Construction Cost		$39.5 Million	$42.7 Million	$35.4 Million	$19.4 Million	$38.7 Million	$24.9 Million
Land Acquisition Cost		$8.0 Million	$6.8 Million	$7.3 Million	$31.3 Million	$6.2 Million	$25.6 Million
Total Lifetime Cost		$50.4 Million	$52 Million	$50 Million	$55.6 Million	$51.7 Million	$56.0 Million

5.3 Feasible Alternatives Analysis

The purpose of this section is to document the process used to evaluate the feasible alternatives.

5.3.1 Natural Flood Protection Evaluation Process

The District Board of Directors (Board) has adopted an Ends Policy 3 which states "There is a healthy and safe environment for residents, businesses and visitors, as well as for future generations." As part of this policy, the Board has adopted a goal that states that "natural flood protection" is to be the method the District uses to provide flood protection. The CEO has interpreted the policy and goal as documented below.

> "Natural stream functions are achieved to the extent feasible and practicable, while providing flood protection and balancing the following:
>
> 1. Homes, schools, businesses, and transportation networks are protected from flooding and erosion.
> 2. Ecological functions and processes are supported.
> 3. Physical stream functions and processes are integrated.
> 4. Maintenance requirements are minimized.
> 5. Projects are integrated within the watershed as a whole.
> 6. The quality and availability of water is protected.
> 7. Cooperation with local agencies achieves mutually beneficial goals.
> 8. Community benefits are provided beyond flood protection.
> 9. Life-cycle costs are minimized."

To comply with the ends policy and CEO interpretation, the Natural Flood Protection (NFP) evaluation process (QEMS work instruction WW75125 - Guidance on Alternative Evaluation and Selection for Natural Flood Protection Projects) was developed to rate and compare flood protection project alternatives. Various criteria were developed to help rate each objective. The objectives and corresponding criteria are listed below.

Objective 1: Homes, schools, businesses, and transportation networks are protected from flooding and erosion.
- Criterion 1: Safety – protection of public safety if conditions exceed design assumptions
- Criterion 2: Economic protection – protection from damage due to floodwaters, erosion or sediment for homes, schools, businesses, transportations systems and other infrastructure
- Criterion 3: Durability – future effort required to maintain design level of protection
- Criterion 4: Resiliency – adaptability to future changes
- Criterion 5: Local drainage – support of local storm drain systems

Criterion 6: Time to implementation – how quickly flood protection elements could become effective

Objective 2: Support ecological functions and processes
- Criterion 1: Local habitat goals – ability to meet habitat goals as defined from examining the watershed as a whole
- Criterion 2: Quality of habitat – quality of habitat provided by alternative
- Criterion 3: Sustainability of habitat – intensity of future action required to maintain design habitat quality
- Criterion 4: Connectivity of habitat – integration of habitat elements into surrounding landscape

Objective 3: Integrate physical stream functions and processes
- Criterion 1: Floodplain – inclusion of appropriately sized floodplain
- Criterion 2: Active channel – appropriateness of size and configuration of active channel
- Criterion 3: Stable side slopes – stability of side slopes
- Criterion 4: Transitions – stability of channel's integration with upstream and downstream reaches

Objective 4: Minimize maintenance requirements
- Criterion 1: Structural features – maintenance associated with structural features
- Criterion 2: Natural processes – maintenance associated with vegetation, erosion and sediment
- Criterion 3: Urban flows – maintenance resulting from small storms and outfall flows
- Criterion 4: Access – incorporation of adequate access for maintenance crews and equipment

Objective 5: Integrate within watershed
- Criterion 1: Meets watershed goals – ability to meet watershed goals as defined in a process that examines the watershed as a whole

Objective 6: Protect the quality and availability of water
- Criterion 1: Water availability – impact on groundwater recharge
- Criterion 2: Instream water quality – water quality protected through vegetation and instream hydraulic complexity
- Criterion 3: Offstream water management – ability to enhance water supply and quality and reduce peak flows through local retention of rainfall
- Criterion 4: Flow regime – ability to maintain geomorphically and biologically appropriate range of flows

Objective 7: Cooperate with other local agencies to achieve mutually beneficial goals
- Criterion 1: Mutual local goals – ability to achieve project-specific goals and objectives developed jointly by the District and local agencies
- Criterion 2: Supports general plan – ability to support goals and policies as stated in general plans of partner agencies

Objective 8: Community benefits beyond flood protection
- Criterion 1: Community safety – overall safety for appropriate access and recreation
- Criterion 2: Recreation – quality of recreation experience provided by alternative
- Criterion 3: Aesthetics – quality of aesthetic form provided by alternative
- Criterion 4: Social and cultural benefits – opportunity to provide community involvement

Criterion 5: Local economic effects – potential effect on property values and/or local business climate
Criterion 6: Green construction and operation – reflection of District's commitment to minimize its impacts on the environment
Criterion 7: Open space – inclusion of open space into alternative
Criterion 8: Community support – alternative reflects community developed objectives and ideas

Objective 9: Minimize life-cycle costs
Criterion 1: Capital cost - net present value of capital costs
Criterion 2: Maintenance cost – net present value of all maintenance costs over the life of the project

5.3.2 Natural Flood Protection Evaluation Results

The first step of the NFP evaluation process is to establish relative weights (high, medium, or low) for each of the objectives. This was done by collecting input from members of the public at meetings in March and November of 2009, from parcel owners along both channels via a survey sent in May 2009, and from staff subject matter experts throughout the planning phase. The weights were then presented to the watershed deputy operating officer for approval. The approved weights can be seen in Table 14.

The second step of the NFP evaluation process is to rate the alternatives based on the individual criteria and overall objectives. Some of the criteria required comparative ratings between the alternatives (for example, which alternative has the least or the most cost) while others were stand-alone ratings (for example, how well does the alternative meet community goals). Each alternative was rated as to how well it accomplished each criterion. The ratings for the criteria under each objective were then assimilated into a summary objective rating per the predefined NFP evaluation process (see Attachment C for NFP rating details). The result is a matrix (see Table 14) which shows a comparison of how well the alternatives rated on each of the nine NFP objectives.

Overall, there is not a substantial difference between the alternatives, with most ratings ranging from adequate to fair. However, three alternatives did rank slightly higher than the others, Alternatives H, J, and B. Alternatives H and J ranked the same but higher than others in maintenance requirements (objective 4), community benefits beyond flood protection (objective 8), and providing flood protection (objective 1). Alternative H has a slight advantage over Alternative J in minimizing life cycle costs (objective 9), with a cost of $50.0 million, compared to $51.7 million. Alternative B is similar to Alternatives H and J in that it received higher ratings for maintenance requirements and flood protection. It is also the second lowest cost alternative at $50.4 million.

There is not enough difference between the top three alternatives for a staff recommended alternative to be designated based on the NFP evaluation. Therefore, the top three alternatives were further developed and evaluated based on the three greatest risks associated with the project: the use of Pond A4 as a detention area, the use of Braly Park as a detention area, and the need for right of way acquisition. Details of this evaluation can be found in the next section of this report.

Table 14. Natural Flood Protection Evaluation Feasible Alternatives Comparison Matrix

		No Project	Floodwalls, Levees, and Erosion Protection	Detention, Floodwalls, Levees, and Erosion Protection	Pond A4, Floodwalls, Levees, and Erosion Protection	Pond A4, Levees, and Erosion Protection	Pond A4, Detention, Floodwalls, Levees, and Erosion Protection	Pond A4, Detention, Levees, and Erosion Protection
Objective	**Objective Weight Rank:**	Alt A	Alt B	Alt D	Alt H	Alt I	Alt J	Alt K
1. Provide protection from flood damage	Low	○	◑	◑	◑	◑	◑	◑
2. Support ecological functions and processes	Medium	◔	◔	◔	◔	◔	◔	◔
3. Integrate physical stream functions and processes	Low	X	X	X	X	X	X	X
4. Minimize maintenance requirements	High	○	◑	◔	◑	◑	◑	◑
5. Integrate within the context of the watershed	Low	◑	◑	◑	◑	◑	◑	◑
6. Protect the quality and availability of water	High	◑	◑	◑	◑	◑	◑	◑
7. Cooperate with other local agencies to achieve mutual goals	High	◔	◔	◔	◔	◔	◔	◔
8. Maximize community benefits beyond flood protection	Med	○	○	◔	◔	○	◔	○
9. Minimize life-cycle costs	Med		$50.4 Million	$52 Million	$50 Million	$55.6 Million	$51.7 Million	$56 Million

Ratings Key:		
●	5	Outstanding
◕	4	Very Good
◑	3	Adequate
◔	2	Fair
○	1	Poor
X	0	Unacceptable

Note 1: Highlighted cells show where a difference exists in the ratings of alternatives (pink is used for high-ranked objectives, yellow is used for medium-ranked objectives, and blue is used for low-ranked objectives). For rows that are not highlighted, there was no difference in the ratings between alternatives.

5.4 Staff Recommended Alternative Development and Selection

The purpose of this section is to document the evaluation and refinement of the top three feasible alternatives.

5.4.1 Risk Identification

Risk identification and assessment for the project focused on three major areas: Pond A4, Braly Detention Area, and right of way acquisition. Based on these areas, the following risks were identified; Table 15 identifies which risks apply to each of the top three alternatives.

Pond A4

- Water quality sampling in Guadalupe Slough, Sunnyvale East and West Channels, and Pond A4 indicate potential issues with toxic conditions
- Habitat changes and potential impacts to protected salt water marsh species resulting from rerouting the channels into Pond A4 are considered unacceptable by the regulatory agencies
- Hydraulic changes to Sunnyvale West Channel negatively impact other dischargers to the channel, including Lockheed Martin, NASA, and the City of Sunnyvale
- Sedimentation in Pond A4 from new interaction with Guadalupe Slough would negatively impact its capacity for storing flood flows over the 50 year design life span

Braly Detention Area

- City of Sunnyvale and Santa Clara Unified School District will not support the Braly Detention Area

Right of Way Acquisition

- Property owners are not willing to sell property to District

Table 15. Risks by Alternative

Risk	Alternative B	Alternative H	Alternative J
Water quality sampling reveals toxic conditions		YES	YES
Habitat changes resulting from rerouting channels into Pond A4 are considered unacceptable by regulatory agencies		YES	YES
Hydraulic changes to Sunnyvale West Channel negatively impact dischargers to the channel		YES	YES
Sedimentation in Pond A4 negatively impacts its capacity for storing flood flows over the 50 year life span of the project		YES	YES
City of Sunnyvale and Santa Clara Unified School District will not support Braly Area Detention			YES
Property owners are not willing to sell property to the District	YES	YES	YES

5.4.2 Risk Assessment

Once the risks were identified, the project team determined the probability of occurrence and the potential impact of each risk for the alternatives. The product of the risk probability and the risk impact is called the risk rating. The project team determined that a Low rating was acceptable, a Medium rating would require further investigation, and a High rating would be unacceptable. Initial analysis of the risks is shown in Table 16. All of the identified risks were shown to have a risk rating of Medium to Medium-High and therefore needed further investigation.

Table 16. Initial Qualitative Risk Analysis Matrix

Risk	Probability of Occurrence	Potential Impact	Risk Rating
Water quality sampling reveals toxic conditions	Low	High	Medium
Habitat changes resulting from rerouting channels into Pond A4 are considered unacceptable by regulatory agencies	Medium	High	Medium-High
Hydraulic changes to Sunnyvale West Channel negatively impact dischargers to the channel	Medium	Medium	Medium
Sedimentation in Pond A4 negatively impacts its capacity for storing flood flows over the 50 year life span of the project	Low	High	Medium
City of Sunnyvale and Santa Clara Unified School District will not support Braly Area Detention	Medium	High	Medium-High
Property owners are not willing to sell property to the District	High	Medium	Medium-High

Further investigation and analysis undertaken for the risk assessment is documented below. The results of this assessment and revisions to the risk matrix can be seen in Section 5.4.3.

5.4.2.1 Pond A4

Water Quality Sampling

In March 2010, water quality samples were taken from the downstream ends of the SEW Channels, Guadalupe Slough, North Moffett Channel, Lockheed Channel, the spur of Sunnyvale West that Sunnyvale Pump Station #1 discharges into, Sunnyvale East near Braly Park, and two locations in Pond A4 (Calhoun, 2010). The purpose of this sampling was to help predict how water quality conditions may change in the various water bodies under the project and to evaluate potential impacts to beneficial uses associated with the basin plan issued by the Regional Water Quality Control Board. Water quality was tested at several locations for physical parameters (oxygen, temperature, salinity). Water samples were taken and tested for aquatic toxicity, metals, pesticides, herbicides, petroleum hydrocarbons, and oil and grease.

Initial analysis indicates there are no immediate concerns with problematic pollutants. There were elevated petroleum hydrocarbons associated with storm water runoff in the area in the preliminary data. This result is not unexpected due to the extent of urbanization immediately adjacent to the project area.

Pond A4 was shown to have the poorest water quality of the sampled water bodies. In particular, concern with oxygen fluctuation and elevated levels of selenium and other metals have been identified. Selenium can have adverse impacts to wildlife and evaporative processes (such as those present in Pond A4 currently) can lead to increased concentrations. Converting Pond A4 into a detention basin and incorporating tidal influence into the system could reduce this evaporative process and may limit selenium concentration increases but requires further investigation. Seasonal variations in the oxygen content of the pond have led to nuisance issues associated with algal blooms and decay and have the potential to impact aquatic wildlife.

If Pond A4 is part of the staff recommended alternative, additional sampling in the fall should be done to capture water quality data from first flush rain events. Further analysis should be completed on Pond A4 and the slough to better understand the selenium issue and established a more comprehensive picture of overall water quality in the project area. Based on identified water quality issues, it is anticipated that measures to address potential water quality impacts could be developed during the design of the project; however the extent of additional studies and additional costs associated with potential measures is unknown. Initial sampling did not reveal existing toxic conditions in Pond A4, which slightly lower the potential impacts. However, sampling did identify issues with selenium and other heavy metals, which require further analysis to fully understand. For these reasons, the probability of occurrence and the potential impact are revised to medium and the risk rating associated with water quality remains medium.

Habitat Changes

Pond A4 is a former salt production pond which was purchased by the District in 2000. Under current operations, Pond A4 receives water originating from Pond A3W through a siphon with Cargill channel at southwest corner of Pond A4. Circulation and water quality in the pond are monitored and maintained by varying the discharge of water from Pond A4 to Pond A5 through a pump at its southeast corner. Pond A3W and A5 are also former salt production ponds, which are currently owned and managed the U.S. Fish and Wildlife Service. The elevation of Pond A4 is maintained to vary no more than 0.9 feet and salinity in the pond stays relatively constant throughout the year, varying between 37 to 40 parts per thousand (ppt). Approximately 7 acres of salt marsh habitat is present along the edge of the pond and is dominated by native pickleweed (Titus, 2010).

As stated before, using Pond A4 as a flood protection facility would convert the pond from an open water salt pond with no interaction with the channels and slough which surround it, to a detention basin which would store flows from the channels, release them to Guadalupe Slough during low tides, and have regular tidal influence during normal conditions. Analysis indicates that these changes would result in a reduction of salinity in the pond from saline (40 ppt) to fresh water (5 ppt). The pond would also have a muted tidal exchange with Guadalupe Slough, resulting in a fluctuating water level in the pond of +/- 0.5 feet. Based on these changes, District biologists predict the 7 acres of salt marsh will be converted to tidal brackish marsh and the pickleweed currently present within Pond A4 will likely transition to native tules or bulrush (Titus, 2010). This conversion could take decades as the future fresh water inputs reduce soil interstitial salinity.

In addition to habitat changes in Pond A4, creating a detention basin would also impact the habitat in the channels themselves. Upstream of the proposed connection with Pond A4, Sunnyvale East contains sections of alkali bulrush higher on its banks, while wetland habitat along Sunnyvale West is almost exclusively comprised of freshwater marsh species. Rerouting the channels would mostly likely result in the loss of existing tidal wetland vegetation along Sunnyvale East but would not result in a loss along Sunnyvale West as the vegetation would most likely migrate towards the bottom and more frequently wet portions of the channel. The remaining portions of both channels downstream of the new connection with Pond A4 would likely be vulnerable to increased sedimentation. This sedimentation could impact the wetland habitat, but further studies are needed to quantify the impacts.

On March 25, 2010, the project team met with Maggie Beth of the Regional Water Quality Control Board and Tami Schane of the Department of Fish and Game to discuss the SEW project. The regulatory staff raised several concerns with the Pond A4 detention concept, including potential changes to water quality conditions (see water quality sampling section above), potential changes to habitat conditions in the pond, channels, and slough and loss of sensitive species that may currently utilize the project area. Of particular concern was the potential presence of the salt marsh harvest mouse and the California clapper rail, both are state and federally listed endangered species. Additionally, both species are considered California fully protected species under California Fish and Game Code Sections 3511, 4700, 5050, and 5515. There is a potential for both species to occur in Pond A4 and Guadalupe Slough and they are both known to occur in salt marsh habitats in area near Pond A4. Actual use of the project area by either species would have to be further evaluated.

Overall, conversion of Pond A4 from a former salt production pond to a flood detention basin would not result in a net loss of wetland habitat in the pond, but would most likely result in a conversion of habitat from salt marsh to tidal brackish marsh. Mitigation may be required for this conversion as it may result in loss of sensitive habitats for endangered and fully protected species. In addition, if any fully protected species are found within Pond A4 or the slough, the ability to implement the Pond A4 element will be extremely challenging. Currently there is no incidental take permission for species listed as fully protected under Fish and Game Code. While there appears that there will no net loss of wetland habitat in Pond A4 and only a small amount of habitat loss in the channel, there are uncertainties associated with the potential presence of fully protected species. Due to these uncertainties, the potential impact from habitat changes remains high and the risk rating remains medium-high.

Hydraulic Changes

Sunnyvale East Channel receives all of its input from the storm drain system, so rerouting the channel into Pond A4 does not affect other dischargers. Sunnyvale West Channel however is more complex. At the downstream end, in addition to flow from the storm drain system, Sunnyvale West receives flow from the Sunnyvale WPCP, pumped discharges from Lockheed and North Moffett Channel (owned by Lockheed Martin and NASA respectively), and pumped discharge from the City of Sunnyvale's Stormwater Pump Station #1. Changes to the configuration and receiving water body of Sunnyvale West Channel could have unwanted consequences to the operations and operational permits of the various dischargers.

The Pond A4 detention basin was initially designed to include all of the above flows. However, further discussions with City of Sunnyvale WPCP staff indicated that rerouting the WPCP discharges into Pond A4 would have major effects on the plants discharge permits and could have significant impacts on the method and cost of treatment. The Pond A4 detention design was then revised so that Sunnyvale East and Sunnyvale West (including the pumped discharges), would flow into Pond A4, but the WPCP discharges would not. Instead, the WPCP discharge pipeline would be extended approximately 200-feet and would empty into the remnant portion of Sunnyvale West Channel. Neither Lockheed Martin, NASA, nor the Sunnyvale Pump Station would be negatively impacted by rerouting of the channels, so these inputs will remain as part of the Pond A4 design. The redesign of Pond A4 minimizes the impacts to other discharges, reducing both the potential impacts and the risk rating to low

Sedimentation in Pond A4

The part of San Francisco Bay located south of the Dumbarton Bridge has been a depositional environment over the past 50+ years; most of the deposited sediments are thought to originate from regions north of the Dumbarton Bridge (Jaffe and Foxgrover, 2005). In addition, tides in Guadalupe Slough are flood-dominant; i.e., the maximum velocity of the flood tide is greater than of the ebb tide, which encourages deposition because the tides are capable of transporting more sediment into the slough than out of it. Under this environment, it is expected that opening Pond A4 to tidal flushing via a slide gate connection with Guadalupe Slough would, over time, cause the pond to fill with sediment up to the mean-higher-high water elevation of the muted tidal range in the pond (Williams and Orr, 2002). This raises the question of whether sedimentation in Pond A4 would fill up the pond to above the planned invert elevation of the tide gates within its 50-year life span; this would adversely impact its capacity for storing flood flows. Although the impact of sedimentation to flood basin operations is high, the project team has concluded that this impact has a low probability of occurring, as explained below.

The design for converting Pond A4 into a flood basin includes construction of a series of 5 tide gates and 1 slide gate built for the purposes of draining the pond after storms and maintaining circulation within it during dry weather conditions, respectively. The current design is to vertically position the bottom of each gate to be about 2.2 feet above the Pond bottom. Then, the question becomes whether sedimentation rates in the proposed flood basin would be sufficient to raise the bottom by more than 2.2 feet in 50 years. A sedimentation study done as part of the Pond A4 Tidal Wetlands Restoration Study (CH2MHill 2006, Section 3.7) estimated that sedimentation rates for the case of a full breach of Pond A4 with Guadalupe Slough would range from 1 to 1.5 cm/year for pond bottom elevations up to the mean low water elevation, which would be below the proposed gate bottom elevation. If these values are adopted, the pond would fill up to the gate bottom elevation within 44 to 61 years. However, sedimentation rates within the proposed flood basin would be significantly smaller than 1 to 1.5 cm/year due to its smaller planned normal-operations opening to Guadalupe Slough of about 7 feet x 0.5 feet and resultant muted tidal range; i.e., an even greater period of time would be required. Therefore, the project team revised the potential impact to low and assigned a low rating to the risk that sedimentation in Pond A4 would significantly impact its operations as a flood basin over 50 years.

5.4.2.2 Braly Detention Area

The original design of the Braly Detention Area was a 4-acre, 8-foot deep area which encompassed all of Braly Park, including the park building, playground area, sand volleyball court and pond (see Figure 18). Conversations with City of Sunnyvale staff revealed that the above mentioned facilities are frequently used by the community and must remain in their current condition. It is not possible to detain enough flow in the remaining portion of the park, so the project team convened a meeting with staff from the City of Sunnyvale and the Santa Clara Unified School District (SCUSD), who own the adjacent baseball field, to discuss other design options. The outcome of the meeting was a revised detention area utilizing both the park and school property, approximately 5.5 acres in size and 5-feet deep with gentle side slopes (Figure 26). The baseball field and tennis courts would be replaced within the bottom of the area. The solid blue line in the figure represents the top edge of the area and the dashed blue line represents the bottom of the detention area.

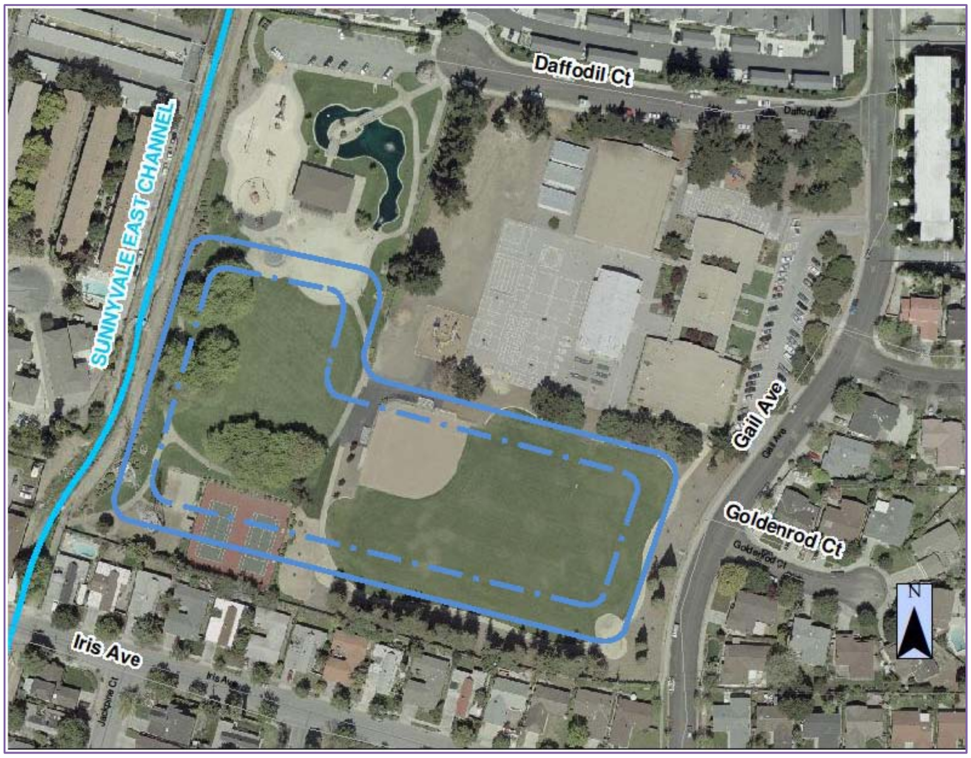

Figure 26. Revised Braly Park and School Detention Area

On February 11, 2010, District staff presented the revised Braly Detention Area idea at the SCUSD Board Meeting. The purpose of the presentation was to introduce the detention concept to the SCUSD Board members and determine if exploring this concept was acceptable. The SCUSD Board had questions about safety, operations and maintenance, and preserving flat play space, but in the end agreed to allowing SCUSD staff to work with the project team to develop the design. A final decision and agreement on the concept will be made when the design is more fully developed. A similar presentation was given to the City Council of Sunnyvale on April 27, 2010 and the council also voted to support further development of the detention concept.

One suggestion from both City of Sunnyvale and SCUSD staff was to replace the existing grass with artificial turf as part of the detention design. This feature is not currently included in the cost estimates for the project. The project team estimates that installation artificial turf and its associated subdrain system could range from $2 - $4 million. In addition, the lifespan of the artificial turf is between 12-15 years; therefore the field surface would need to be replaced up to 3 times within the lifespan of the project, at an estimated cost of $500,000 per replacement. The use of artificial turf in a flood detention area may also complicate the permitting process. Based on the positive outcomes from SCUSD and City of Sunnyvale meetings, the potential impacts are low and the risk rating associated with this option is now also low.

5.4.2.3 Right of Way Acquisition

Per a request from watershed field operations unit, the floodwalls for the project are being designed on the outboard side of the channels to allow for better access to the channels for repair and maintenance. In order to place the floodwalls on the outboard side of the channel, there needs to be adequate right of way available. The need for right of way acquisition was initially determined by comparing distance between the inboard top of bank and the property line. If a maintenance road is present, the required right of way needed to install floodwalls is at least 19 feet (15 feet for the road + 1 foot floodwall width + 3 feet between wall and property line to allow for access for vegetation maintenance, more space may be needed between the wall and the right of way line if the footing is large). If a maintenance road is not present, the required right of way need is the footing width plus 1.5 feet to allow adequate room for construction. These limitations were applied to the feasible alternatives to determine the right of way need.

As the risk rating related to right of way acquisition was determined to be medium-high, the project team further refined the right of way requirement analysis to determine if there were ways to reduce the need for land acquisition. The initial right of way determination relied on digital maps and landmarks in aerial photos. To further refine the right of way requirements, the right of way lines were staked in several questionable areas by the Survey Unit and the project team met with staff from the West and Guadalupe Field Operations and Program Support unit to determine if there were ways to lessen the amount of right of way needed.

Along Sunnyvale East Channel, right of way requirements were reduced by eliminating the need for a road along the right side of the channel (all references assume looking downstream) from Old San Francisco Road to Evelyn Avenue and reducing the width of road needed on the right side of the channel from Highway 101 to Tasman Drive from 15 feet to 10 feet. Along Sunnyvale West Channel, right of way requirements were reduced by reducing the width of road need on the right side of the channel from Bordeaux Drive to Java Drive from 15 feet to 10 feet. These changes not only reduced the total square footage of right of way needed, but also eliminated the need for land acquisition on single family housing property. The remaining properties are either commercial parking lots, landscaped areas, or parking lots of apartments or condos. As the potential impacts associated with right of way acquisition have been limited in area and scope, the potential for occurrence has been reduced to medium and the risk rating is reduced from medium-high to medium.

5.4.3 Revised Risk Assessment

Based on the analysis outlined in the sections above, the qualitative risk assessment has been revised as documented in Table 17 below.

Table 17. Revised Qualitative Risk Analysis Matrix

Risk	Probability of Occurrence	Potential Impact	Risk Rating
Water quality sampling reveals toxic conditions	Medium	Medium	Medium
Habitat changes resulting from rerouting channels into Pond A4 are considered unacceptable by regulatory	Medium	High	Medium-High
Hydraulic changes to Sunnyvale West Channel negatively impact dischargers to the channel	Medium	Low	Low
Sedimentation in Pond A4 negatively impacts its capacity for storing flood flows over the 50 year life	Low	Low	Low
City of Sunnyvale and Santa Clara Unified School District will not support Braly Area Detention	Medium	Low	Low
Property owners are not willing to sell property to the District	High	Low	Medium

5.5 Refined Alternative Details

Based on the risk assessment and updated hydraulic modeling, refinements were made to the top three alternatives. Details of these changes are summarized below; Table18 summarizes the comparison between the three refined alternatives and is provided at the end of this section.

Refined Feasible Alternative B: Floodwalls, Levees and Erosion Protection

Alternative Description
As described before, this alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality (Figure 27).

Along Sunnyvale East Channel, average floodwall/levee heights range from 2.5 to 5.5 feet in the following locations: south of Evelyn Avenue, between Wolfe Road and Duane Avenue, and north of Highway 101 to the confluence with Guadalupe Slough**.** Updates to the hydraulic models eliminated the need for floodwalls near of Blythe Avenue and just south of Highway 101.

Along Sunnyvale West Channel average floodwall heights range from 0.5 to 4.5 feet from Mathilda Avenue to Carl Road and existing levees are raised from 1 to 4.5 feet from Carl Road to the confluence with Guadalupe Slough.

The slight increase of floodwall and levee heights along both channels is due to an increase of the starting water surface. Explanation of this increase can be found in Appendix A of this report.

Erosion protection remains the same as described in feasible alternatives section.

Further details for this refined alternative are provided in Appendix A.

Land Ownership/Access
Based on the right of way and maintenance access refinements made during the risk assessment, the amount of right of way needed and number of parcels affected has decreased. It is now expected that strips of land from 3 parcels (as compared to 9) on Sunnyvale East Channel and 11 parcels (as compared to 12) on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative B.

Detailed land ownership and access information can be found in Appendix A.

Cost Estimate
Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$40,600,000
Land Acquisition:	$ 6,700,000
Maintenance:	$ 2,900,000
Total Lifetime Cost:	$50,200,000

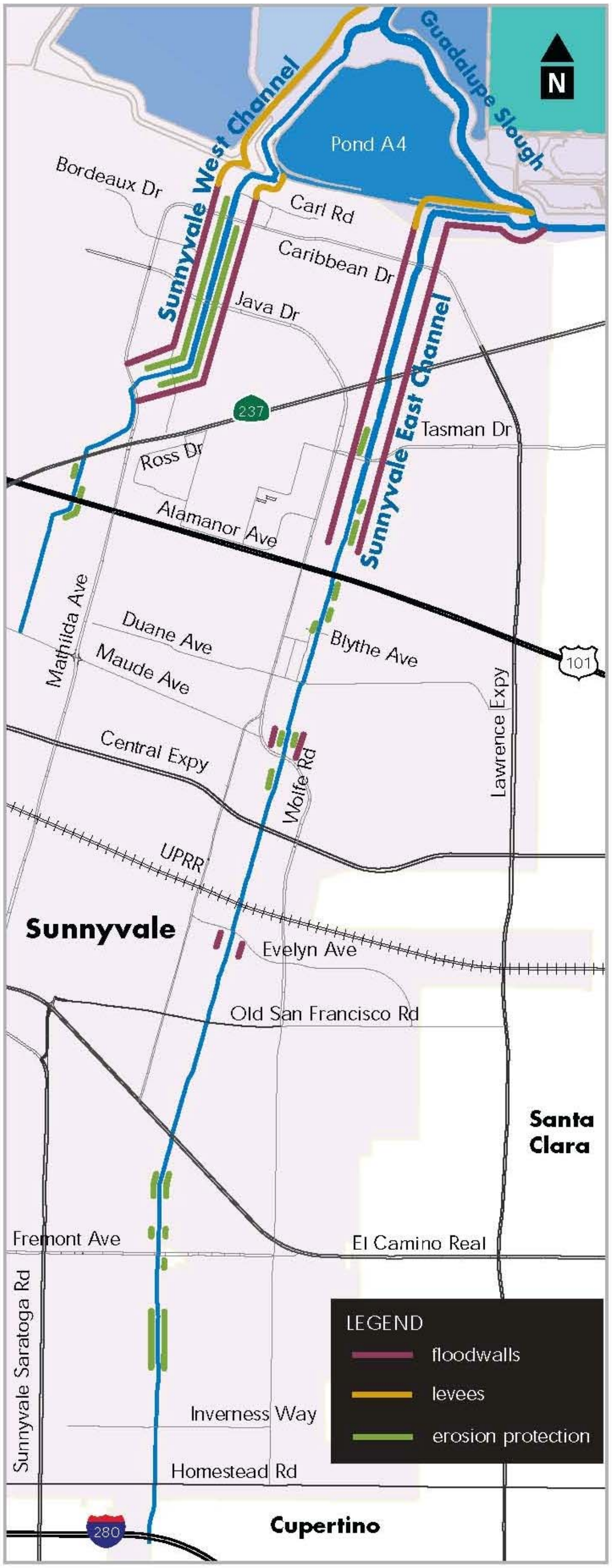

Figure 27. Refined Feasible Alternative B- Floodwalls, Levees, and Erosion Protection

Refined Feasible Alternative H: Pond A4, Floodwalls, Levees and Erosion Protection

Alternative Description
As described before, this alternative combines Pond A4, floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality (Figure 28).

Pond A4 would be converted to a detention basin by rerouting the SEW Channels to flow into the pond, installing slide and tide gates to regulate flow between Pond A4 and Guadalupe Slough, and raising existing levees around the pond to provide adequate capacity.

The locations of the floodwalls and levees along Sunnyvale East are similar to Refined Alternative B; however rerouting the channels into Pond A4 reduces the height required. The average floodwall/levee heights range from 1.5 to 5.5 feet near Evelyn Avenue, between Wolfe Road and Duane Avenue, and north of Highway 101 to the new connection with Pond A4**.** Updates to the hydraulic models eliminated the need for floodwalls near of Blythe Avenue and just south of Highway 101.

Along Sunnyvale West Channel, rerouting the channel into Pond A4 reduces the height of floodwalls/levees from Mathilda Avenue to Carl Road to an average of 1.0 to 2.0 feet.

Erosion protection remains the same as described in feasible alternatives section.

Further details for this refined alternative are provided in and Appendix A.

Land Ownership/Access
Based on the right of way and maintenance access refinements made during the risk assessment, the amount of right of way needed and number of parcels affected has decreased. It is now expected that strips of land from 3 parcels on Sunnyvale East Channel (as compared to 9 estimated under original feasible conditions) and 3 parcels on Sunnyvale West Channel (as compared to 7 estimated under original feasible conditions) would need to be acquired by the District in fee or easement for the construction of Alternative H.

Detailed land ownership and access information can be found in Appendix A.

Cost Estimate
Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$34,000,000
Land Acquisition:	$ 3,000,000
50 Yr Maintenance:	$ 7,300,000
Total Lifetime Cost:	$44,300,000

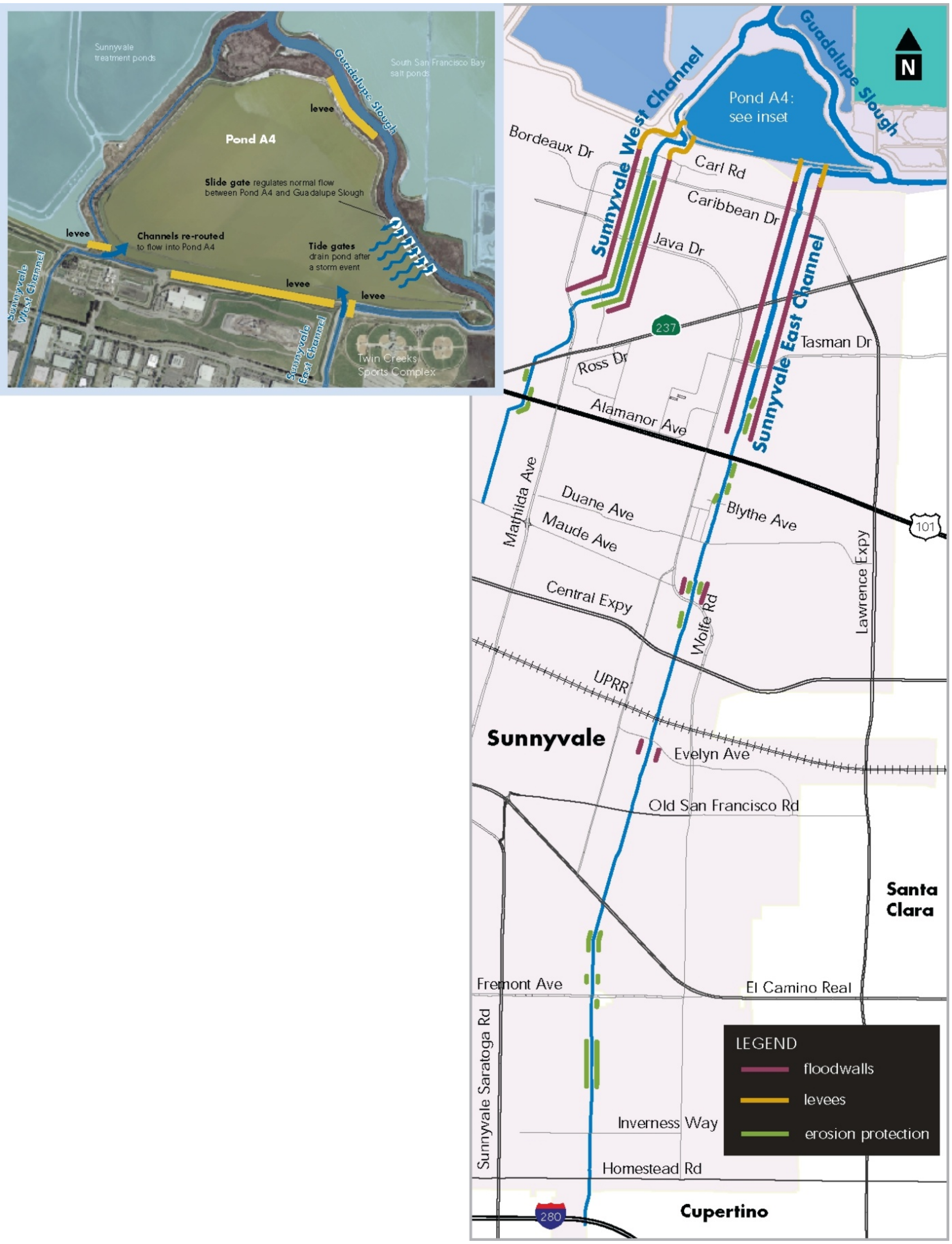

Figure 28. Refined Feasible Alternative H – Pond A4, Floodwalls, Levees, and Erosion Protection

Refined Alternative J: Pond A4, Detention, Floodwalls, Levees and Erosion Protection

As described before, this alternative combines Pond A4, detention, floodwalls, levees and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 29).

Pond A4 would be converted into a detention basin as described in Refined Alternative H.

Braly Park would be converted into a detention area as described in Section 3.2.2

Along Sunnyvale East Channel, average floodwall/levee heights range from 1.5 to 3.5 feet north of Highway 101 to the confluence with Guadalupe Slough the new connection with Pond A4**.**

Along Sunnyvale West Channel, rerouting the channel into Pond A4 reduces the height of floodwalls/levees from Mathilda Avenue to Carl Road to an average of 1.0 to 2.0 feet.

Details for this alternative are provided in Appendix A.

Land Ownership/Access
Based on the right of way and maintenance access refinements made during the risk assessment, the amount of right of way needed and number of parcels affected has decreased. It is now expected that strips of land from 1 parcel on Sunnyvale East Channel (as compared to 2 estimated under original feasible conditions) and 2 parcels on Sunnyvale West Channel (as compared to 7 estimated under original feasible conditions) would need to be acquired by the District in fee or easement for the construction of Alternative J.

Cost Estimate
Cost estimates are in 2010 dollars and the maintenance cost were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

Construction:	$ 38,100,000
Land Acquisition:	$ 2,200,000
50 Yr Maintenance:	$ 6,800,000
Total Lifetime Cost:	$ 47,100,000

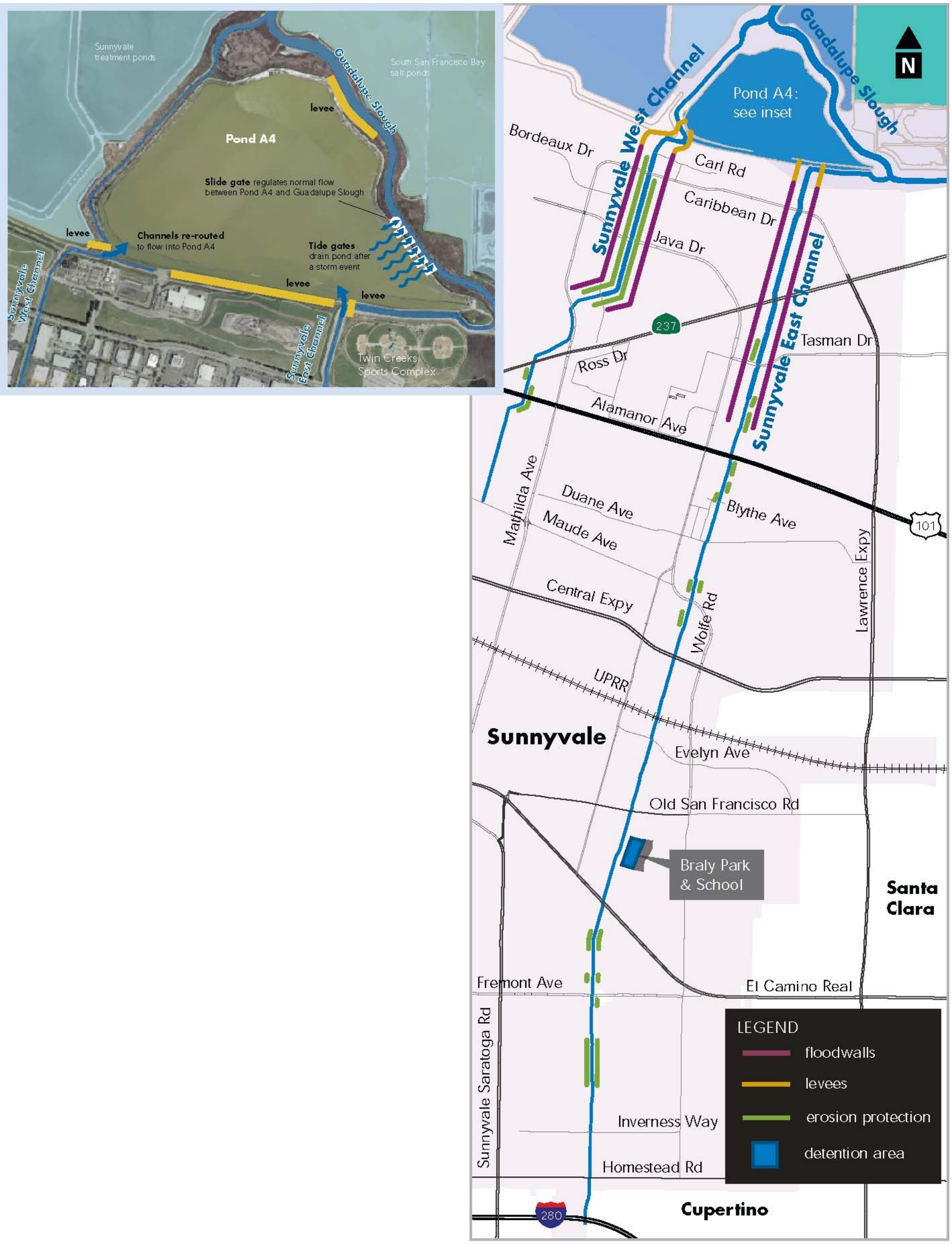

Figure 29. Refined Feasible Alternative J – Pond A4, Detention, Floodwalls, Levees, and Erosion Protection

Table 18. Refined Alternatives Summary

		Alt B	Alt H	Alt J
Sunnyvale East Channel	Floodwalls	2.5 - 5.5 ft high	1.5 - 5.5 ft high	1.5 - 3.5 ft high
		for 2 mi	for 1.5 mi	for 1.4 mi
	Levees	Raise Pond A4 levee by 4.5 ft for 0.5 mi	No Levees	No Levees
Sunnyvale West Channel	Floodwalls	0.5 - 4.5 ft high	1 - 2 ft high	1 - 2 ft high
		for 1 mi	for 1 mi	for 1 mi
	Levees	0.5 - 3 ft high	2 ft high	2 ft high
		for 3/4 mi	for 0.2 mi	for 0.2 mi
Land Acquisition	Residential/ Commercial Parcels	0/14	0/6	0/3
	# of homes	No homes taken	No homes taken	No homes taken
Detention				X
Pond A4			X	X
New Operations and Maintenance Activities			Reduced Sediment Removal In Channels	Reduced Sediment Removal In Channels
		Additional Graffiti Removal	Additional Graffiti Removal	Additional Graffiti Removal
				Cleaning Braly Park (after large storms, every 7-8 years)
			Operating Slide Gate on Pond A4 Before and After Storms	Operating Slide Gate on Pond A4 Before and After Storms
			Maintenance of Inlets, Tide Gates, and Slide Gate	Maintenance of Inlets, Tide Gates, and Slide Gate
			Sediment Removal from Outlet Channel in Guadalupe Slough	Sediment Removal from Outlet Channel in Guadalupe Slough
O&M Cost	Annually	$20,000	$50,000	$47,000
	Over 50 yrs	$2.9 Million	$7.3 Million	$6.8 Million
Construction Cost		$40.6 Million	$34 Million	$38.1 Million
Land Acquisition Cost		$6.7 Million	$3 Million	$2.2 Million
Total Lifetime Cost		$50.2 Million	$44.3 Million	$47.1 Million

5.6 Alternatives Comparison

Alternative B

Alternative B only has one of the identified risks, right of way acquisition, which has been reduced from a rating of medium-high to medium. This alternative is, however, the highest cost alternative with a capital cost of $47.3 million and a 50-year maintenance cost of $2.9 million for a total of $50.2 million. Alternative B also provides flood protection by the most basic means by simply increasing the channel capacity by building floodwalls. It does not remove the channels from backwater effects from other channels or reduce the peak flows in the channels. The channels also remain under tidal influence, which means they will continue to require sediment removal in the downstream reaches and will be subject to effects from sea level rise.

Alternative H

Alternative H has five of the identified risks including all of the Pond A4 risks and the right of way acquisition risks. The right of way risk applies to all the alternatives however, compared to Alternative B; Alternative H requires less right of way acquisition and would therefore have a slight advantage over Alternative B for this risk. The hydraulic and sedimentation risks associated with Pond A4 have been reduced to low and therefore no longer are factors for comparison. The water quality and habitat risks have been better defined, but still remain at a medium and medium-high rating respectively. The water quality issue will require additional sampling and evaluation, which may delay the project. The risks associated with the habitat changes in Pond A4 will also require further investigation and study, which may also result in a delay in the project schedule. Permitting for the project will also be more complex and time consuming than originally estimated in the schedule. The exact impact to the schedule is difficult to estimate at this time, but a conservative estimate would be an addition of 1 to 2 years to the design schedule. A delay of more than 1 year would make it difficult for the project to meet the objective of providing riverine flood protection by December 2016. In addition to schedule impacts, there may also be mitigation required for impacts to wetland habitat that would add to both internal and capital costs. Based on the other tidal wetland restoration projects in the San Francisco Bay, mitigation for tidal salt marsh could cost around $40,000 per acre (or $280,000 total for the 7 acres of wetland within Pond A4).

Although this alternative has two medium risks and one medium-high risk, it remains the lowest cost alternative with a capital cost of $37 million and a 50-year maintenance cost of $7.3 million for a total of $44.3 million. Alternative H also provides a more comprehensive flood protection approach than Alternative B by not only increasing the channel capacity, but also decreasing the downstream boundary conditions and removing backwater flows. This combination of methods is preferable to merely increasing the channel capacity as it isolates the channels from influences outside of the channels' watersheds and reduces the needed capacity of the channels. It also removes the channels from future effects from sea level rise and eliminates the need for sediment removal in the downstream reaches.

Alternative J

Alternative J has all of the identified risks. The hydraulic, sedimentation, and Braly Area detention risks have been reduced to low and therefore no longer are factors for comparison. The right of way risk has a medium rating; however, Alternative J requires the least amount of right of way acquisition compared to the other alternatives. The water quality and habitat risks associated with Pond A4 and the likely impact to the project schedule remain the same as discussed under Alternative H above.

This alternative is the second lowest cost alternative with a capital cost of $40.3 million and a 50-year maintenance cost of $6.8 million for a total of $47.1 million. Alternative J provides the most comprehensive form of flood protection in that it increases channel capacity, reduces downstream boundary conditions, removes the channels from tidal and backwater effects, and reduces peak flows by diverting them from the channel during storm events. It also removes the channels from future effects from sea level rise and eliminates the need for sediment removal in the downstream reaches.

5.7 Staff-Recommended Alternative

The project team recommends Alternative H, which combines floodwalls, levees, and Pond A4, as the staff-recommended alternative. The basis for this recommendation is a combination of the results of the Natural Flood Protection (NFP) evaluation process, the additional risk analysis performed by the project team, and the project team's judgment.

As discussed above, the NFP process did not clearly identify a single, best alternative, but rather identified Alternatives B, H and J as preferable to the others. A risk assessment was performed to further refine the selection process. The initial assessment suggested that from a risk perspective Alternative B was preferable to Alternatives H and J, because it has fewer risks; specifically, it lacks the risks associated with the Pond A4 and the Braly Park and School detention area elements. Further analysis reduced the hydraulic changes and sedimentation risks of Pond A4 and the Braly detention to low ratings, which is an acceptable level of risk and eliminated these risks for comparison purposes. While the water quality and habitat risks for Pond A4 remain at medium and medium-high ratings respectively, the larger amount of right of way acquisition (also a medium risk) required by Alternative B as compared to Alternatives H and J, cancels out the initial apparent risk advantage of Alternative B.

Alternative B has few risks, but it is the most expensive option and provides flood protection by only one method, increasing capacity of the channel. It also leaves the channels susceptible to future sea level rise. Alternative H has five of the six risks, but it is the least costly alternative and provides flood protection by increasing capacity and removing the channels from tidal influence and back water effects. It removes the channels from influence from future sea level rise and reduces sediment removal. Alternative J has the most risk, is the second least expensive and provides the most comprehensive flood protection by increasing capacity, removing the channels from tidal influence and back water effects, and reducing peak flows by diverting flows to the detention area. As the risk difference between the alternatives has been minimized, the choice is now based on cost and flood protection methods. From a flood protection perspective, Alternative J would be the recommended alternative as it provides the most comprehensive protection. However, the detention area will cost approximately $4.3 million and only reduce the total length of floodwalls by a few hundred feet. The cost of construction the detention area does not appear to offer equivalent benefits.

It is the judgment of the project team that, although all of the top three alternatives provide the same level of flood protection, the mechanisms for doing so in Alternative H are the most comprehensive and cost effective. In summary, the project team feels that these additional benefits and method for providing flood control outweigh the risks associated with this alternative and thereby recommends Alternative H – Pond A4, Floodwalls, Levees, and Erosion Protection as the staff-recommended alternative.

6 Staff-Recommended Alternative

This section provides the design basis, project element details, and right-of-way needs for the staff-recommended alternative. A description of the maintenance guidelines for the project is included in Section 7 and cost details are included in Section 8.

6.1 Design Criteria

The following design criteria were used to develop the staff-recommended alternative.

6.1.1 General

- The design life of the project is assumed to be 50 years.

- Flood protection facilities in project areas south of the San Francisco Bay Shoreline (south of the southern boundary of Pond A4) will be designed to meet FEMA and District standards.
    - 1.0 foot of freeboard in section of channel without levees
    - 3.5 feet of freeboard in sections of channel with levees.
    - 4 feet of freeboard in sections of channel with levees within 100 feet of structures or wherever flow is constricted.

- The maintenance roads' widths will be determined independently for each site by consulting watershed maintenance staff for actual needs.
    - o For most locations, maintenance roads will be maintained at a minimum width of 15-feet with a minimum width of 22-feet near road crossings to allow turning access for cranes with outriggers
    - o For reaches with existing maintenance roads on both banks, the project team may eliminate the maintenance road on one of the banks.
    - o For reaches where there is very low risk of large debris or trees entering the channel, the project team may maintain a minimum maintenance road width of 10 feet instead of 15.

- The project team has evaluated the project per Executive Limitations Policy EL- 7.7, and determined that based on currently available information, anticipated sea level rise over the next 50 years will be accommodated within the project design. See Section 3.4 and the Feasible Alternatives Decision Memorandum dated 8/3/2009 for more details.

6.1.2 Pond A4

- Pond A4 will be designed with capacity to receive the following inflow sources

    a. Simultaneous 100-year flow hydrographs on the Sunnyvale East and West Channel Watersheds that would result from a 24-hour storm.

    b. Inflow from Pump Station Number 1, which drains a part of northern Sunnyvale and empties to Sunnyvale West Channel; see Table 6 for flow values.

    c. Inflow from Lockheed Pump Station, which drains Lockheed‘s campus and Moffett Field; see Table 6 for flow values.

- The inboard freeboard requirement is to maintain 1 foot of freeboard above the maximum water surface elevation which would result from the design inflow conditions; the outboard freeboard requirement is to maintain levees which are higher than the 100-year tide with sea level rise.

- Pond A4 will be designed to have an average water surface elevation close to the existing managed pond level of 1.05 ft NAVD88.

- Pond A4 will be designed so as not to restrict future work to provide tidal flood protection by the Shoreline Project or any future project.

- Pond A4 will drain within 72 hours after the end of the District’s simulated100-year flow hydrographs for the Sunnyvale East and West Channels which would result from a 24-hour storm.

- Pond A4 will be designed to prevent erosion problems around each constructed element.

- Pond A4 will minimize adverse impacts to existing habitat and water quality; improve if possible.

- The City of Sunnyvale’s water pollution control plant effluent pipeline will be re-routed via a siphon to flow into the remnant part of Sunnyvale West Channel, which runs along the north-west side of Pond A4.

6.1.3 Levees

- Levees will be built to have side slopes of 2:1 (horizontal: vertical)

- Settlement
    - Levees will be overbuilt to account for total settlement from primary consolidation. Settlement due to primary consolidation from levee construction is estimated as follows:

Table 19. Estimated Settlement Due to Primary Consolidation from Levee Construction

Channel	Reach	Primary Consolidation from Levee Construction
		inches
Sunnyvale East	Pond A4 - Caribbean	2 to 12
Sunnyvale West	Pond A4 – Carl	18 to 36

6.1.4 Floodwalls

- The floodwalls would be constructed on the outboard side of the access roads or top of levees.

- A minimum width of 3-feet will be maintained between the floodwalls and the right of way to allow for maintenance access for debris removal and weed control.

- Settlement
  - Locations along the channels requiring floodwalls will be pre-loaded to account for settlement from both under-consolidation and primary consolidation. Cost estimates for this work have not been included at this phase of the project; however it is assumed that the 35% construction contingencies will cover this work.

  - Under-consolidated soils have been identified along Sunnyvale East Channel from the south side of Caribbean Drive to Highway 101. Settlement due to this under-consolidation is estimated to be between 10 to 14 inches.

  - Settlement due to primary consolidation from floodwall construction is estimated as follows:

Table 20. Estimated Settlement Due to Primary Consolidation from Floodwall Construction

Channel	Reach	Primary Consolidation from Floodwall Construction
		inches
Sunnyvale East	Pond A4 - Caribbean	1 to 6
	Caribbean – Hwy 237	1 to 3
	Hwy 237 - Tasman	0.5 to 2
	Tasman – Hwy 101	0.5 to 3
	Duane - Wolfe	1 to 4
	Evelyn to STA 199+92	1 to 4
Sunnyvale West	Carl – Caribbean	1 to 3
	Caribbean – Java	1 to 3
	Java - Bordeaux	1 to 3
	Bordeaux - Mathilda	1 to 3

In addition to the design criteria listed here, the project team has been asked to investigate alternative methods for disposal of sediments excavated for the purposes of constructing the floodwalls. As part of the design phase, the project team will look into the possibility of disposal of sediments within Pond A4.

6.2 Staff-Recommended Project Description

The staff-recommended project for the SEW Channel Flood Protection Project is Alternative H: Floodwalls, Levees, Pond A4, and Erosion Protection. Details of the Pond A4, levees, floodwalls, and erosion protection elements are described below.

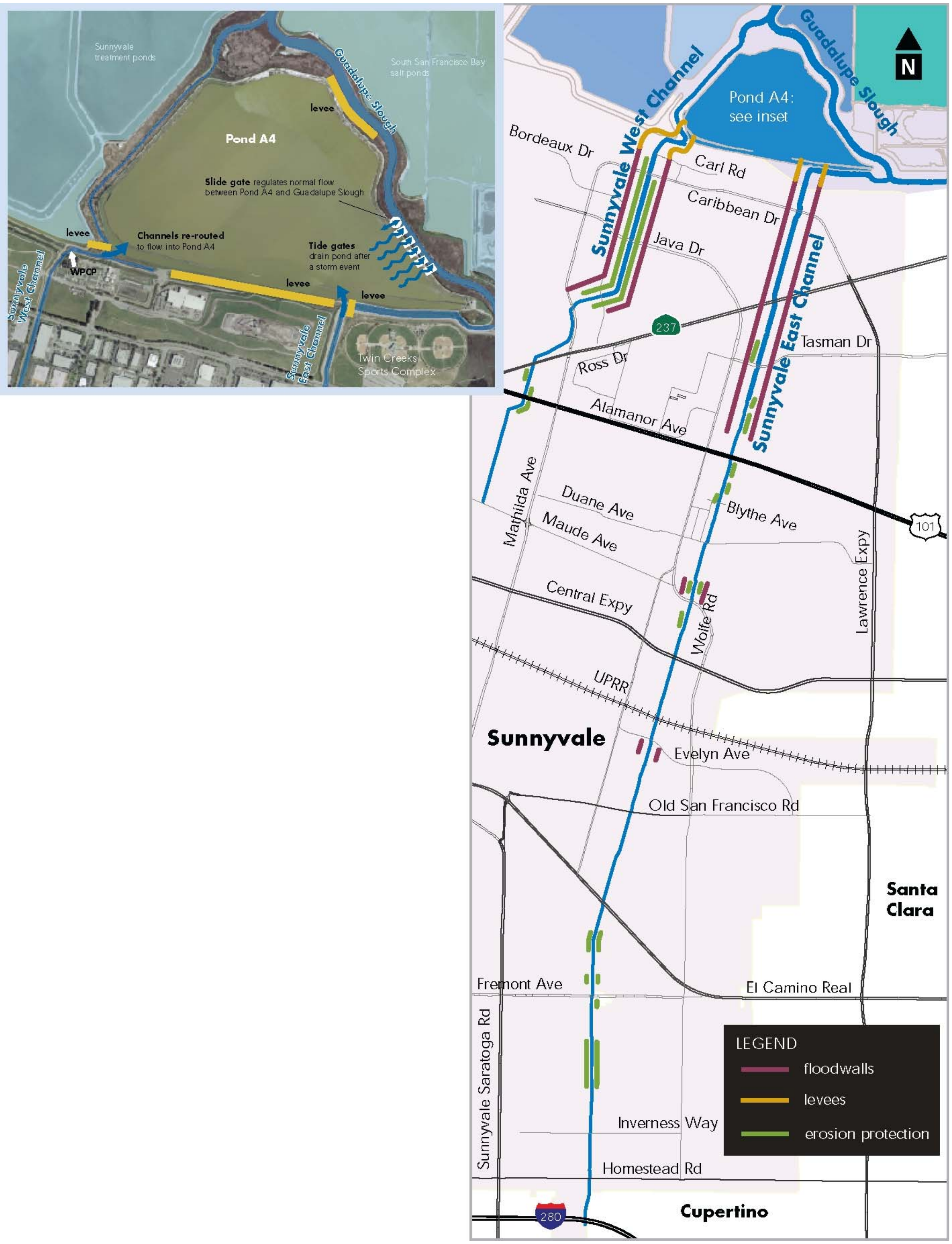

Figure 30. Staff-Recommended Alternative H

6.2.1 Pond A4

The Pond A4 element of the staff-recommended alternative provides flood protection by re-routing the SEW Channels to flow into Pond A4, rather than into Guadalupe Slough. This re-alignment would remove the channels from tidal influence from the San Francisco Bay and from backwater effects from large flows on Guadalupe Slough due to inputs from San Tomas Aquino and Calabazas Creeks. Pond A4 would be converted from a managed open water pond isolated from the surrounding channels and slough, to a detention basin which would store flow from the channels temporarily and release them to Guadalupe Slough during low tides. It is anticipated that modifications to Pond A4 and Guadalupe Slough will modify the existing habitat conditions and existing water quality parameters.

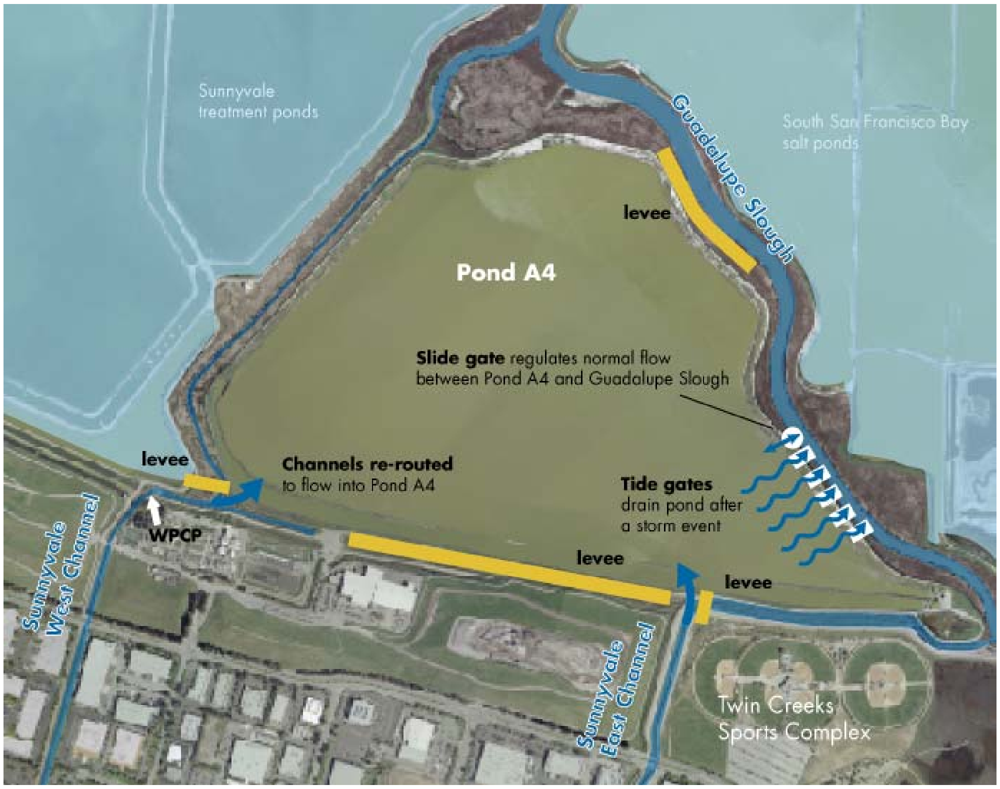
Sunnyvale treatment ponds
South San Francisco Bay salt ponds
Guadalupe Slough
levee
Pond A4
Slide gate regulates normal flow between Pond A4 and Guadalupe Slough
levee
Channels re-routed to flow into Pond A4
Tide gates drain pond after a storm event
WPCP
levee
levee
Sunnyvale West Channel
Sunnyvale East Channel
Twin Creeks Sports Complex

Figure 31. Pond A4 Detention Basin

Several changes would be required to convert Pond A4 into a detention basin. First, both of the SEW Channels would be rerouted to flow into Pond A4 by creating two breaches along the south side of the levee surrounding Pond A4. These breaches would mimic the size and shape of the channels and would be designed to prevent erosion. As part of this realignment, it would be necessary to construct levees to the west and east of the proposed connections of Pond A4 with Sunnyvale West and East Channels, respectively, for the purpose of blocking off tidal flows. These levees would be constructed to have similar dimensions to the existing levees around the pond. The remnant channel portions would remain tidally influenced. Second, the levees around and near Pond A4 would be raised to prevent overtopping due to high tides and/or large flow events on Guadalupe Slough. Specifically, this would require raising levees along the south side of the remnant portion of Sunnyvale East Channel, along the south side of Pond A4 by 1 to 2 feet for a distance of about 2900, and along the northeast side of Pond A4 by 1 foot for a distance of about 900 feet. Lastly, five tide gates and one slide gate would be installed between Pond A4 and Guadalupe Slough. The slide gate would remain open under dry-weather conditions, but would be closed during storm events, allowing the pond to function as a detention basin for storage of storm water. The pond would drain via the tide gates during subsequent low tides. The gates would be supported by a concrete box structure with a pile foundation. A rock-lined channel would be constructed on the Guadalupe Slough side of the box structure to help reduce erosion potential when the pond drains after a storm event.

In addition to changes to Pond A4 itself, this element would also require work in the surrounding area. The Sunnyvale WPCP currently discharges to Sunnyvale West Channel around Station 55+00, near the south-west corner of Pond A4. City of Sunnyvale staff have indicated that having flows from the WPCP discharging into Pond A4 would have unwanted consequences to the plant's discharge permits. Therefore, the discharge pipe would need to be extended to the remnant portion of Sunnyvale West Channel, located downstream of the new connection between Pond A4 and the upstream portions of the channel.

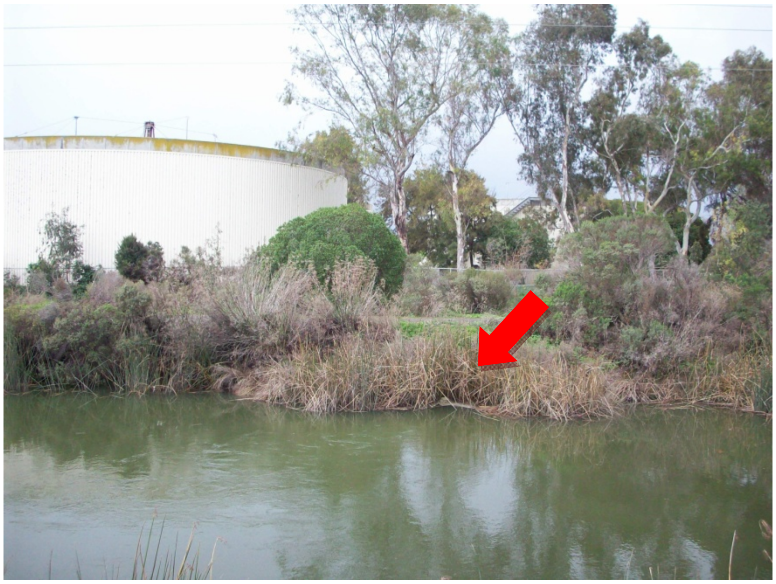

Figure 32. Existing location of WPCP discharge pipe into Sunnyvale West Channel

Realigning the channels would also require that the pedestrian bridge that crosses Sunnyvale East Channel and provides access to the Bay Trail and the bridge at Carl Road that crosses Sunnyvale West Channel be replaced.

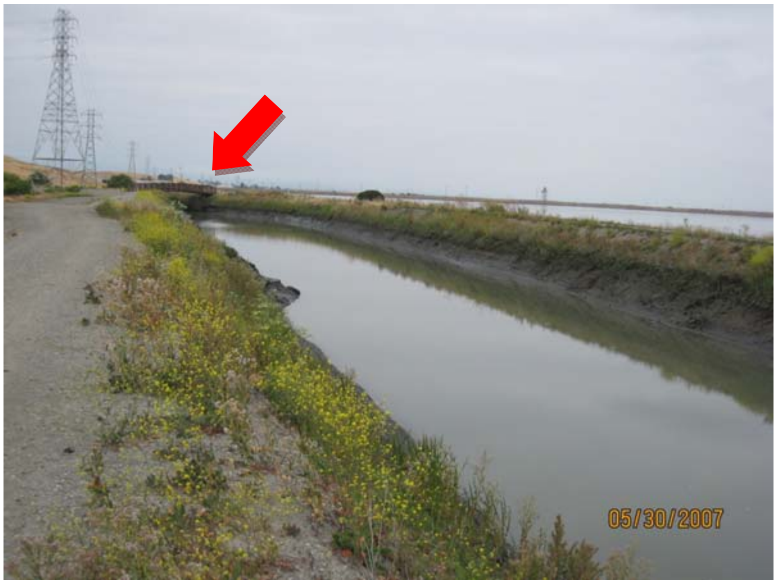

Figure 33. Pedestrian Bridge over Sunnyvale East Channel to be replaced (Pond A4 to the right)

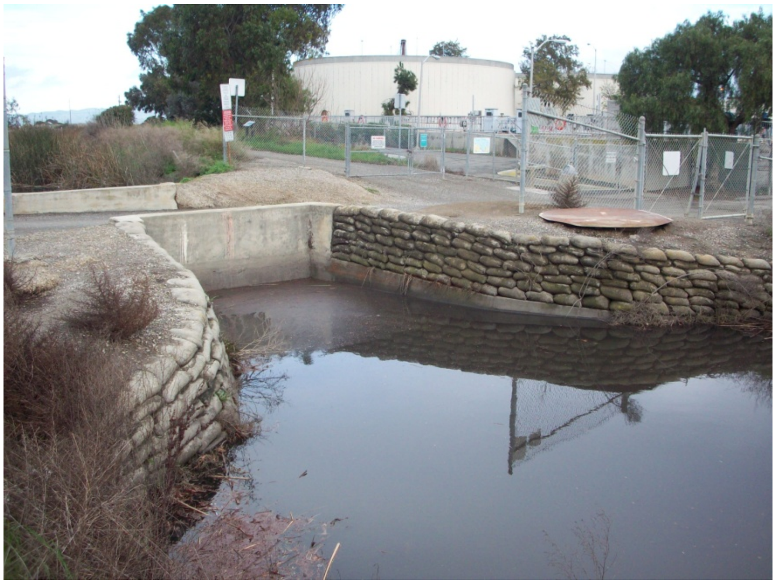

Figure 34. Carl Road Bridge over Sunnyvale West Channel to be replaced

6.2.2 Levees

Immediately upstream of the new Pond A4 connection to station 30+00 along Sunnyvale East Channel and to Carl Road along Sunnyvale West Channel, levees would be installed in areas requiring flood protection. Levees are proposed in this area rather than floodwalls to better blend with the surrounding landscape.

Sunnyvale East Channel
Reach E1 would be modified by raising levees immediately adjacent to the new connection with Pond A4.

Sunnyvale West Channel
Reach W1 would be modified by raising the existing levees by 1 foot on both banks between Carl Road and the new connection with Pond A4 and Sunnyvale West Channel.

6.2.3 Floodwalls

Upstream of station 30+00 along Sunnyvale East Channel and Carl Road along Sunnyvale West Channel, floodwalls would be installed in areas requiring flood protection. Floodwalls were chosen in this area over levees as there is limited right-of-way along the channels and floodwalls have a smaller footprint as compared to levees. In addition most of the land adjacent to the channels is surrounded by fencing or landscaping, which block views of the channels. The installation of floodwalls along the channel would not change the existing views of the channels and will blend well with the existing surroundings.

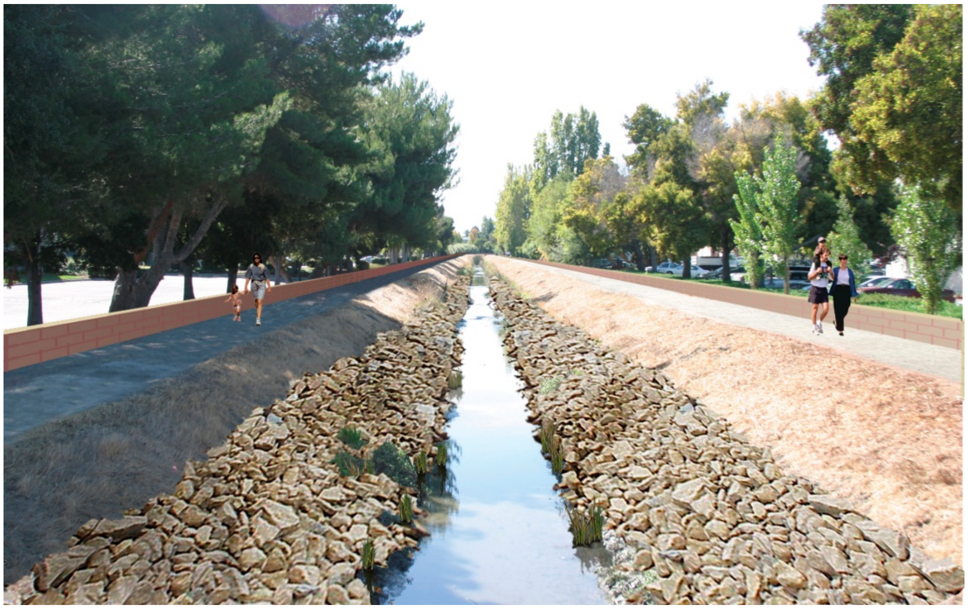

Figure 35. Example of floodwalls along Sunnyvale West Channel at Java Drive

Sunnyvale East Channel
Reach E1 would be modified by the addition of floodwalls for the length between Carl Road and Caribbean Drive. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Drive and Highway 101. Reach E3 would be modified by the addition of floodwalls for the entire length between Duane Avenue culvert entrance and Wolfe Road. Reach E4 would be modified by the addition of floodwalls for a 160-foot length immediately upstream of Evelyn Avenue.

Table 21. Above-Bank Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Above-Bank Height (ft)	Right Above-Bank Height (ft)
E4	Immediately upstream of Evelyn Avenue	4.5	5.5
E3	Wolfe Road to Duane Avenue	4	4.5
E2	Hwy 101 to Tasman Drive	3.5	3.5
	Tasman Drive to Hwy 237	2	2
	Hwy 237 to Caribbean Drive	3.5	4
E1	Caribbean Drive to Carl Road	1.5	1.5

Sunnyvale West Channel

Reach W1 would be modified by the addition of floodwalls between Carl Road and Caribbean Drive. Reach W2 would be modified by the addition of floodwalls on both banks for the entire length between Caribbean Drive and Bordeaux Drive and on the left bank only for the entire reach between Bordeaux Drive and Mathilda Avenue.

Table 22. Above-Bank Floodwall Heights on Sunnyvale West Channel

Reach	Location	Left Bank Above-Bank Height (ft)	Right Bank Above-Bank Height (ft)
W2	Mathilda Avenue to Bordeaux Drive	1	0
	Bordeaux Drive to Java Drive	1.5	1.5
	Java Drive to Caribbean Drive	2	2
W1	Caribbean Drive to Carl Road	2	2

6.2.4 Berms

There are portions of Sunnyvale West Channel that are un-leveed and have 1% capacity, but do not have 1-foot of freeboard as required by the District freeboard standards. On average, these areas require 0.5 feet of additional height in order to meet the District standards. In these areas, fill will be placed on the channel access road creating a berm to provide the 1 foot of required freeboard.

Sunnyvale East Channel

Reach E3 would be modified by the addition of berms on one or both banks immediately upstream of Highway 101, from Blythe Avenue to Duane Avenue, on one bank from Wolfe Road to Arques Avenue, and on both banks from Arques Avenue to Central Expressway. Reach E4 would be modified by the addition of berms on both banks from UPRR to Evelyn Avenue and on one bank from Evelyn Avenue to Old San Francisco Road.

Table 23. Above-Bank Berm Heights on Sunnyvale East Channel

Reach	Location	Left Bank Above-Bank Height (ft)	Right Bank Above-Bank Height (ft)	Length (ft)
E3	immediately upstream of Highway 101	0.2	0.2	80
	Blythe Avenue to Duane Avenue	0.6	0.6	80
	Wolfe Road to Arques Avenue	n/a	0.2	120
	Arques Avenue to Central Expressway	0.5	0.5	30
E4	UPRR to Evelyn Avenue	0.5	0.5	120
	Evelyn Avenue to Old San Francisco Road	n/a	0.7	190

6.2.5 Erosion Protection

Sunnyvale East Channel

Bank and toe erosion repairs are needed in reaches E6 (two locations), E5 (two locations), E4 (one location), E3 (six locations), and E2 (three locations) on Sunnyvale East Channel. Details of the erosion repair locations are listed below.

Reach E6

Dunholme to Carlisle

- Slumping as high as 5 to 6 feet on both banks.
- Length = 600 feet (River Station 297+00 to 291+00)
- Maximum channel velocity = 6.83 ft/sec

Ashbourne to Fremont

- Slumping on east bank only
- Length = 35 feet (River Station 274+71 to 274+36)
- Maximum channel velocity = 5.26 ft/sec

Reach E5

Fremont to Crescent

- Erosion in transition area between hardscape and natural materials on both banks
- Length = 20 feet (River Station 272+50 to 272+30)
- Maximum channel velocity = 5.71 ft/sec

Crescent to El Camino

- Slumping on both banks
- Length = 600 feet (River Station 260+00 to 254+00)
- Maximum channel velocity = 6.74 ft/sec

Reach E4

Iris to Old San Francisco

- Scouring and slumping failure on the west bank immediately downstream of a sac-concrete reach
- Length = 50 feet (River Station 225+52 to 225+02)
- Maximum channel velocity = 13.29 ft/sec

Reach E3

Kifer to Pedestrian Bridge
- Failure of existing sack concrete on west bank
- Length = 62 feet (River Station 183+81 to 183+19)
- Maximum channel velocity = 16.69 ft/sec

Central Expressway to Arques
- Toe erosion and some slumping failure on the west bank
- Length = 335 feet (River Station 168+92 to 165+57)
- Maximum channel velocity = 10 ft/sec

Arques to Wolfe
- Slumping failure and toe erosion on west bank
- Length = 450 feet (River Station 163+30 to 158+80)
- Maximum channel velocity = 6.37 ft/sec

Wolfe to Duane
- Slumping failure and toe erosion on both banks in sections between hardscape
- Length = 325 feet (River Station 152+41 to 149+16)
- Maximum channel velocity = 5.33 ft/sec

Blythe to PG&E #3
- Slumping failure on west bank
- Length = 194 feet (River Station 124+57 to 122+63)
- Maximum channel velocity = 6.41 ft/sec

PG&E #3 to Highway 101
- Slumping failure on east bank
- Length = 177 feet (River Station 121+77 to 120+00)
- Maximum channel velocity = 6.34 ft/sec

Reach E2

Highway 101 to PG&E #2
- Slumping failure on east bank
- Length = 600 feet (River Station 103+54 to 97+54)
- Maximum channel velocity = 6.79 ft/sec

PG&E #2 to Tasman
- Slumping failure between hardscaped sections on east bank
- Length = 70 feet (River Station 93+52 to 92+82)
- Maximum channel velocity = 3.33 ft/sec

Tasman to PG&E #1
- Toe erosion up to 3-feet high on west bank
- Length = 854 feet (River Station 82+81 to 74+27)
- Maximum channel velocity = 3.59 ft/sec

For planning purposes, the rock toe bank slope protection method has been selected for all erosion repairs. This method is appropriate for the identified erosion sites, which have steep side slopes (1.5:1, H:V, or steeper) and velocities lower than 7 ft/sec. It consists of protecting the toe and lower banks with rock up to the 10-year flow level and repairing the slope above this level with a combination of earth fill, erosion protection fabric, and hydroseed. With this method, the channel would be repaired to have a trapezoidal cross section with 2:1 (H:V) side slopes. It also provides a conservative cost estimate of the erosion protection element of the project.

As the extent of erosion along the channels is continually changing due channel flows and repairs by the watershed staff, the information in this section is considered preliminary. The exact locations and dimensions of the erosion locations will be finalized during the design phase of the project and erosion protection methods will be customized to each repair site; where possible, the project team will adopt geomorphic design principles. For example, a successful repair was recently completed on Sunnyvale East Channel in the reach upstream of Blythe Avenue which involved creating a bankfull channel and adjacent small floodplain bench. Similar approaches may be possible in areas with sufficient right-of-way corridor.

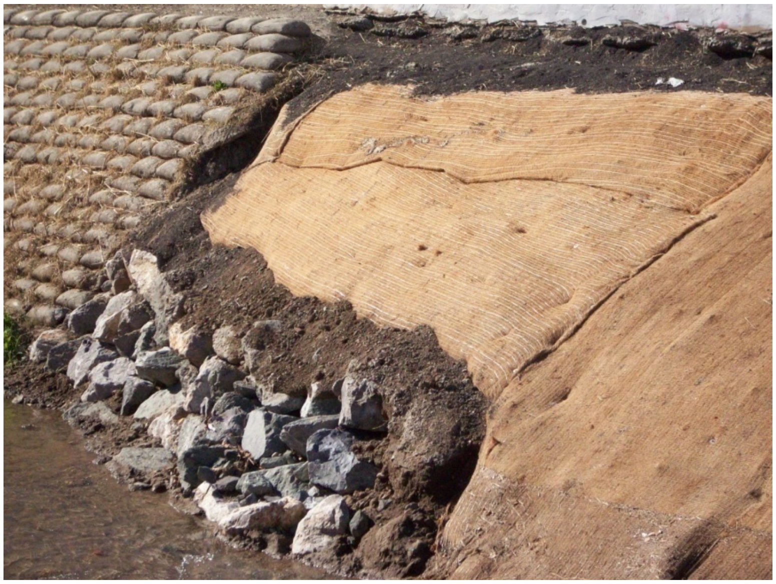

Figure 36. Example of rock toe and earth fill slope protection installed on Sunnyvale East Channel, downstream of Duane Avenue

There is evidence of invert erosion at two locations in Reach E4 (between Iris Avenue and Old San Francisco Road and between Old San Francisco Road and Evelyn Avenue) and one location in E3 (between Central Expressway and Arques Avenue). These locations do not currently require repair, but should be monitored for further degradation after large storms.

Sunnyvale West Channel

Bank and toe erosion repairs are needed in reaches W4 (two locations), W2 (two locations), and W1 (one location). Details of the erosion repair locations are listed below.

Reach W4

Parking Lot Culvert to Highway 101

- Lateral toe erosion on the east bank on the outside of a bend, 3 to 4 feet deep
- Length = 210 feet (River Station 150+90 to 148+80)
- Maximum channel velocity = 9.44 ft/sec

Highway 101 to Ross
- Toe erosion 4 to 5 feet deep on the west bank
- Length = 50 feet (River Station 146+55 to 146+05)
- Maximum channel velocity = 10.58 ft/sec

Reach W2

Bordeaux to Java
- Slumping and toe erosion on both banks
- Length = 1872 feet (River Station 105+86 to 87+14)
- Maximum channel velocity = 4.88 ft/sec

Java to Caribbean
- Slumping and toe erosion on both banks
- Length = 1852 feet (River Station 85+70 to 67+18)
- Maximum channel velocity = 1.69 ft/sec

Reach W1

Caribbean to Carl
- Slumping and toe erosion on west bank
- Length = 300 feet (River Station 65+00 to 62+00)
- Maximum channel velocity = 0.73 ft/sec

The same repair method used for Sunnyvale East Channel, rock toe bank slope protection method, will be used for Sunnyvale West Channel.

There is evidence of invert erosion at two locations in Reach W4 (between the beginning of the open channel in the parking lot and Highway 101 and between Highway 101 and Ross Drive) and one location in W2 (between Mathilda Avenue and Bordeaux Drive). These locations do not currently require repair, but should be monitored for further degradation after large storms.

6.3 Right of Way Requirements

It is expected that strips of land from 3 parcels on Sunnyvale East Channel and 3 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of the staff-recommended alternative

Along Sunnyvale East Channel, acquired lands would include commercial properties (parking) and parks and recreation facilities (Fair Oaks Park) between Wolfe Road and Duane Avenue and open space property owned by the City of Sunnyvale between Highway 101 and Tasman Drive.

Table 24. Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)
E3	Wolfe Road to Duane Avenue	3	10
E2	Hwy 101 to Tasman Drive	0	7

Along Sunnyvale West Channel, acquired lands would include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the WPCP property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table 25. Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)
W2	Mathilda Avenue to Bordeaux Drive	6	0
W1	Carl Road to Pond A4 Connection	13	5

6.4 Identification of Environmental and Recreational Enhancement Opportunities

The SEW Project objectives include the identification of feasible opportunities for environmental and recreational enhancements.

6.4.1 Environmental Enhancement Opportunities

Trash Reduction

Opportunities exist to improve the water quality in Sunnyvale East and West Channels by reducing the amount of trash that enters the channels through the City of Sunnyvale storm drain system. The City of Sunnyvale recently initiated a pilot study which installed StormTek catch basin inserts at eight locations in the Sunnyvale East Channel watershed and five locations in the Sunnyvale West watershed. The StormTek catch basin insert consist of a perforated metal screen attached to the catch basin outlets that allows water to flow from the catch basin, but traps trash for removal and proper disposal.

An environmental enhancement opportunity is to support the City's future endeavors in trash abatement through a partnership.

Storm-water Runoff Reduction

Another environmental opportunity is to reduce the quantity of storm-water runoff and improve water quality by implementing a storm-water runoff reduction incentive program. If the City implements such a program, the District could consider partnering to support this effort.

The program would be based on a program currently being implemented by the City of Palo Alto. The Palo Alto program offers rebates for the installation of rain barrels and underground or above-ground cisterns, the replacement of traditional pavement with permeable pavement, and the replacement of traditional roofing material with "green roofs".

6.4.1 Recreational Enhancement Opportunities

Trails

The opportunity exists to create trails along both the Sunnyvale East and Sunnyvale West Channels. The City of Sunnyvale has identified the channels as opportunities for trail development in their Parks of the Future Plan.

The recreational enhancement opportunity is to support the City's future endeavors in trail creation through a partnership.

7 MAINTENANCE PROGRAM

7.1 Maintenance History

Regular maintenance work has been conducted within the SEW Channel watershed since construction in the 1960's. This work includes both channel processes maintenance (sediment removal, debris removal, and vegetation control) and infrastructure replacement maintenance (repair/replacement of sacked-concrete or rock).

7.2 Historic Creek Maintenance

Due to the hydro-modification of the watershed area due to urbanization and tidal effects, sedimentation has been an issue in the watershed of the SEW Channels. Sediment deposition has historically occurred along the entire length of Sunnyvale East Channel and between Mathilda Avenue to Carl Road on Sunnyvale West Channel. The significance of the sediment removal efforts can be shown by the volume of sediment removed from the watershed over time. Figures 37 and 38 shows the historic maintenance activities on the SEW Channels.

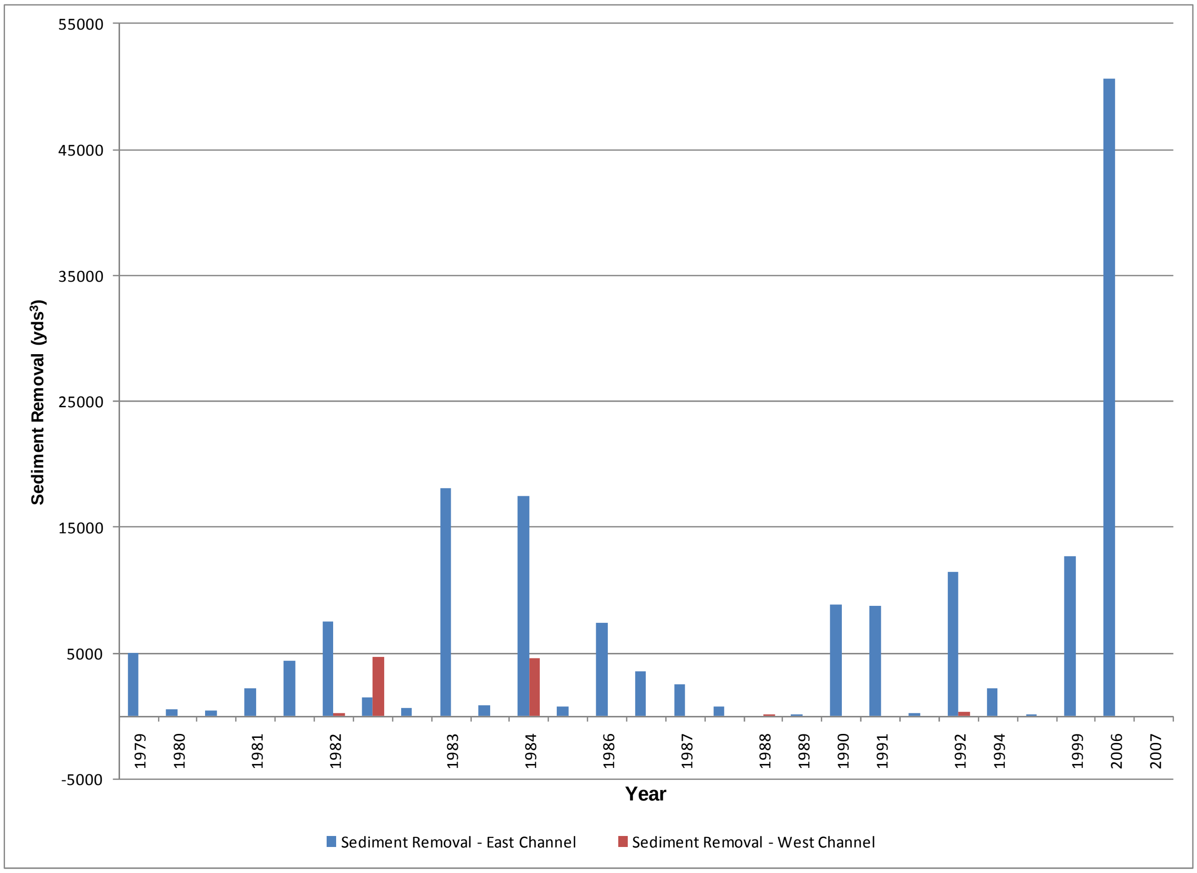

Figure 37. Sediment Removal 1977 - 2010

The historical average annual sediment removal (since 1979) at the Sunnyvale East Channel is approximatly 3,695 cubic yards and approximatly 1,990 cubic yards on Sunnyvale West Channel. Sediment removal downstream of Highway 101 is mostly associated with tidal issues and therefore does not correlate with strong winter precipitation years.

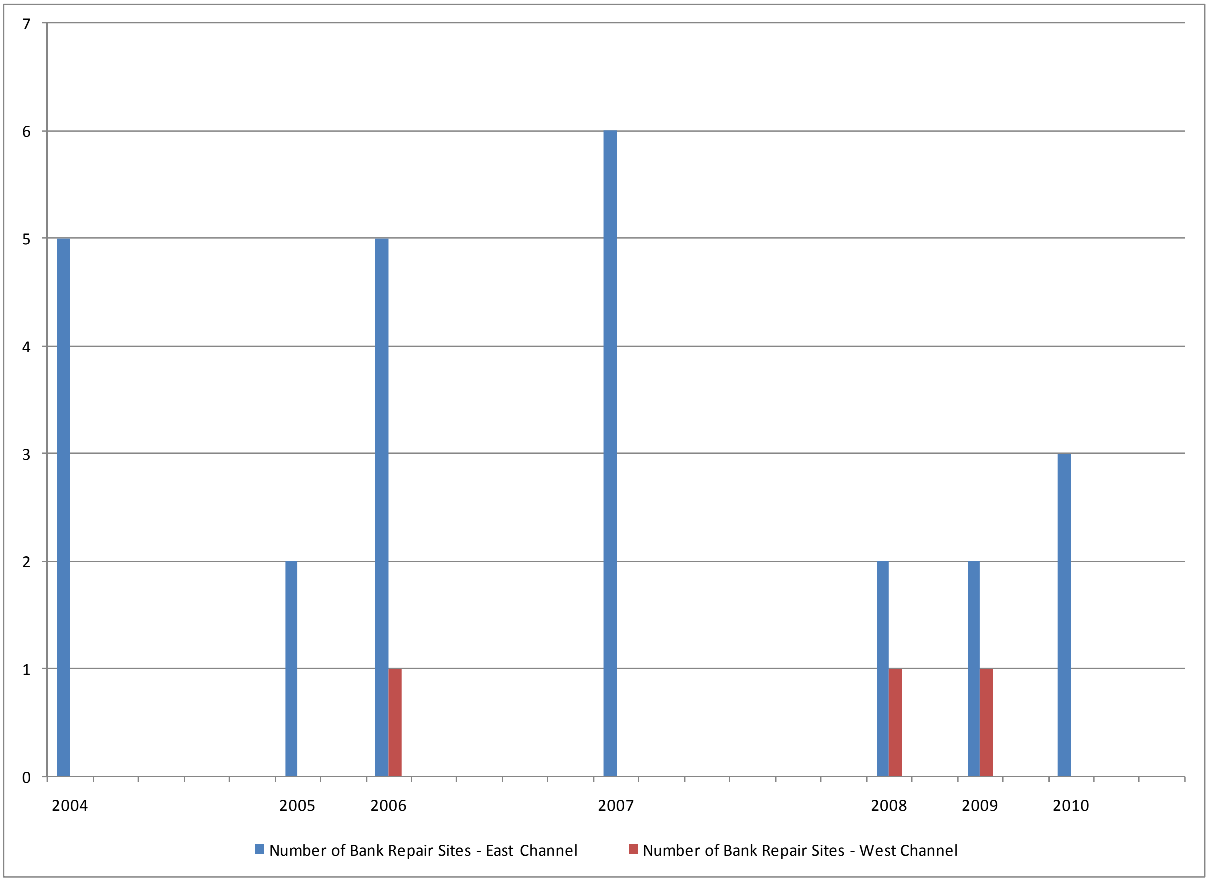

Figure 38. Number of Bank Repairs Annually 2000 -2010

Historically, Sunnyvale East Channel expierenced four bank erosion repairs per year and Sunnyvale West Channel experienced one erosion repair per year.

In addition to sediment removal and bank repair, the District conducts the following maintenance activities along Sunnyvale East Channel and Sunnyvale West Channel:

- Vegetation control on and adjacent to levees by mowing and spraying
- Rodent control by trapping and baiting
- Maintenenace road repair and preventative maintenance and spraying
- Trash Removal and debris removal at bridges and along access roads and in the channel
- Natural and low-flow channel maintenance
- Graffiti abatement

7.3 Ongoing Maintenance Activities

The SEW Channel Maintenance Program provides long term maintenance guidance for routine and long term stream maintenance work. This section discusses the current maintenance activities on the channels.

Sediment Maintenance: The Stream Maintenance Program (SMP) allows for sediment removal on Sunnyvale East Channel from Highway 101 to the Guadalupe Confuence and from Mathilda Avenue to Carl Road on Sunnyvale West Channel. Watershed staff evaluate channel conditions semi-annually to identify necessary future maintenance activities. Sediment removal is performed on an as needed basis per the SMP.

Vegetation Maintenance: The following vegetation maintenance is performed on an annual cycle:

> ***Levees:*** Prevent the growth of vegetation along top of the levee maintenance roads and the establishment and growth of woody and shrub vegetation along leveed slopes or tops.. Continue current vegetation control by mowing and spraying. Future woody growth removal will require hand removal.
>
> ***Natural and Low-flow Channels:*** Monitor for hazardous tree conditions, channel blockages and other conditions that would impede flow or create local drainage problems. Continue current vegetation control practices.

Structural Maintenance: The following structural maintenance is performed on an annual cycle (unless otherwise noted):

> ***Levees:*** Levee tops and slopes are monitored for erosion damage and repaired as needed. Continue current rodent control by traping.
>
> ***Maintenance Access Roads:*** Asphalt-paved, contrecte-paved and soil-cement roads are monitored for cracking and potholes and repaired as needed. Aggregate base roads are monitored for erosion and potholes and repaired as needed; measures are taken to prevent vegetation growth.
>
> ***Sacked-Concrete:*** Sacked-concrete erosion protection is monitored for failure and repaired as needed.

Debris/Graffiti Removal: The debris and graffiti removal projects will continue per the District Good Neighbor Program. It consists of monthly and quarterly cleanup events, response to graffiti and trash complaints, and repairs/installation of fences and signs around District facilities.

7.4 Staff-Recommended Alternative Maintenance Activities

The following maintenance activities would be required by the staff-recommended alternative.

Sediment Maintenance: The installation of erosion protection measures and re-routing of the channels into Pond A4 would reduce the sediment deposition due to tidal flushing in the channels and thereby the sediment maintenance activities.

Vegetation Maintenance: No additional maintenance required.

Structural Maintenance:

> ***Levees/Berms:*** The construction of new levees and berms would require additional monitoring of the tops and slopes; erosion damage would be repaired as needed.
>
> ***Maintenance Access Roads:*** No additional maintenance required.
>
> ***Sacked-Concrete:*** No additional maintenance required.
>
> ***Floodwalls:*** The construction of floodwalls would require visual monitoring for cracks, spalls and other types of damage; repairs would be performed as needed. The right-of-way corridor adjacent to the outside face of floodwalls would be regularly maintained by clearing it of weeds and trash. Woody vegetation would be removed from within five feet of the inside face of walls, except where such vegetation is intentional.

Debris/Graffiti Removal: Graffiti removal would increase due to the construction of floodwalls. The maintenance activities would be incorporated as part of the Good Neighbor Program. Maintenance activities such as trash and debris removal would be the same as under the existing condition.

Pond A4 Flood Basin: Operation and maintenance of Pond A4 is assumed to involve monthly inspection of the tide and slide gates, a twice annual inspection of the inlets and the pond from the channels, and annual sediment removal from the outlet channels to Pond A4.

7.5 Long Term Infrastructure Maintenance

Like all man-made structures, the new floodwalls, culverts, channel reaches, and other infrastructure that would be built by this project would eventually require replacement. Therefore, the calculated project maintenance costs (see below) include provisions for structural replacement costs estimated for the project’s design lifespan of 50 years.

7.6 Staff-Recommended Alternative Maintenance Cost

The estimated additional annual maintenance cost for the staff-recommended alternative is itemized and summarized below in Table 26. Costs were escalated to the 50-yr total value using a 3.7 percent compounding interest rate. Additional information on how each activity was calculated can be found in Appendix B.

Table 26. Maintenance Costs

Activity	Staff-Recommended Alternative
Graffiti	$ 19,800
Increased Mowing and Weed Control	$ -
Detention Basin	$ -
Pond A4	$ 29,840
Total per Year	$ 49,640
Total per Year (nearest 1000)	$ 50,000
Over 50-Years (includes escalation costs)	$ 7,268,204

8 PROJECT COST, FUNDING, AND SCHEDULE

8.1 Project Cost

8.1.1 Capital Cost

The overall capital cost for the staff-recommended project would be $37 million in 2010 dollars including construction, land acquisition, and contingencies.

The capital cost estimate is summarized below in Table 27. A detailed cost estimate is provided in Appendix B.

Table 27. Staff-Recommended Project Capital Cost Estimate

Project Element	Cost ($ million, 2010)
Floodwalls	
Sunnyvale East	10.4
Sunnyvale West	4.2
Levees	
Sunnyvale West	0.1
Pond A4	4.6
Erosion Protection	
Sunnyvale East	2.2
Sunnyvale West	3.6
Contingencies	8.8
Land Acquisition	
Sunnyvale East	2.1
Sunnyvale West	0.9
Pond A4	0.1
Total	37.0

8.1.2 Maintenance Cost

The annual maintenance cost for the staff-recommended alternative would be $50,000 per year, as shown in Table 28.

Table 28. Staff-Recommended Project Annual Maintenance Cost Estimate

Maintenance Activity	Annual Cost
	($, 2010)
Graffiti Removal	20,000
Pond A4 Maintenance	30,000
Total	50,000

The total maintenance cost for the 50-year life of the project would be $7.3 million dollars, assuming a 3.7% compounding interest rate to account for escalation.

8.2 Project Funding

The proposed Project would be paid for by funds from the 2000 voter-approved Clean, Safe Creeks Program. The cost of construction and land acquisition for the staff-recommended alternative is estimated at $37 million in 2010 dollars. The total allocation from the Clean Safe Creeks Program to the Sunnyvale East and Sunnyvale West Channel Flood Protection Project is $43 million. To date about $5 million has been spent on planning and preliminary design. Design and environmental documentation costs are estimated at $5 million.

8.3 Project Schedule

Project design is expected to begin in FY 2010-11 and is anticipated to be completed in early 2013. Construction would be conducted in 2013 and 2014.

9 CONCLUSIONS AND RECOMMENDATIONS

The existing capacities of Sunnyvale East and Sunnyvale West Channels are insufficient to contain the design flow rates. If flood protection is not improved, 1,618 parcels along Sunnyvale East Channel and 11 parcels along Sunnyvale West Channel will remain susceptible to 100-year riverine flood events. Erosion along both channels threatens the stability of existing flood protection facilities and negatively affects water quality. If erosion protection is not improved, water quality along the channels will continue to suffer and existing and future flood protection facilities could be prone to failure.

The staff-recommended alternative would protect the community from the 100-year riverine flood event and accomplish the District's Natural Flood Protection objectives. The staff-recommended alternative would result in the following benefits:

Flood Protection
The staff-recommended alternative would provide 100-year riverine flood protection to 1,618 parcels along Sunnyvale East Channel and 11 parcels along Sunnyvale West Channel.

The staff-recommended alternative would remove the channels from tidal influence and from effects from future sea level rise.

The staff-recommended alternative would remove the channels from back water effects from other Guadalupe Slough, San Tomas Aquino Creek, and Calabazas Creek.

Erosion Protection
The staff-recommended alternative would provide a total of 2 miles erosion protection along the channels improving water quality and protecting flood protection facilities from failure.

Maintenance
The need for annual sediment removal and bank erosion repair would be greatly reduced.

The staff-recommended alternative meets all the of project objectives, balances the Natural Flood Protection objectives, and provides the most comprehensive and cost effective flood and erosion protection. Therefore, it is recommended that the staff-recommended project be approved and detailed plans and specifications be developed for its construction.

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Santa Clara Valley Water District

Sunnyvale East Channel and Sunnyvale West Channel Flood Protection Project

Planning Study Report

Appendix A

Alternative Details

June 2010

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1 Appendix Purpose

The purpose of this appendix is to provide the general and alternative specific assumptions and design details for the feasible alternatives for the Sunnyvale East and West Channels Flood Protection Project (SEW Project).

2 Development of Alternatives and Design Criteria

The District's planning process generally has three stages: development of conceptual alternatives, development of feasible alternatives and finally the development of a staff-recommended alternative. For the SEW Project, during the conceptual alternative planning stage, the project team identified numerous approaches to meet the project objectives. Each of these approaches is referred to as a *Conceptual Project Element* (CPE). The CPEs were developed during the conceptual phase and refined during the feasible stage. The CPEs used in the feasible alternatives development and the general and specific assumptions associated with them are listed below.

General Design Criteria

- The design life of the project is assumed to be 50 years.

- Flood protection facilities in project areas south of the San Francisco Bay Shoreline (south of the southern boundary of Pond A4) will be designed to meet FEMA and District standards.
  - 1.0 foot of freeboard in section of channel without levees
  - 3.5 feet of freeboard in sections of channel with levees.
  - 4 feet of freeboard in sections of channel with levees within 100 feet of structures or wherever flow is constricted.

- Flood protection facilities in project areas north of the San Francisco Bay Shoreline (north of the southern boundary of Pond A4) will be designed to convey the 100-year channel flow with 1-foot of freeboard.

  - Facilities will be designed so as not to restrict future work to provide tidal flood protection by the Shoreline Project or any future project.

- The project team has evaluated the project per Executive Limitations Policy EL- 7.7, and determined that based on currently available information, anticipated sea level rise over the next 50 years will be accommodated within the project design. See Feasible Alternatives Decision Memorandum dated 8/3/2009 for more details.

- Maintenance roads will be maintained at a minimum width of 15-feet. If possible, a minimum width of 22-feet near road crossings will be maintained to allow turning access for cranes with outriggers.

Design Criteria for Floodwalls (CPE 2)

This CPE would provide flood protection by creating a concrete barrier that would contain flow within the channel thereby increasing the overall channel capacity.

- The floodwalls would be constructed on the outboard side of the access roads or top of levees.

- A minimum width of 3-feet will be maintained between the floodwalls and the right of way to allow for maintenance access for debris removal and weed control.

- Settlement

    - Under-consolidated soils have been identified along Sunnyvale East Channel from the south side of Caribbean Drive to Highway 101. Settlement due to this under-consolidation is estimated to be between 10 to 14 inches.

    - Settlement due to primary consolidation from floodwall construction is estimated as follows:

Table A1. Estimated Settlement Due to Primary Consolidation from Floodwall Construction

Channel	Reach	Primary Consolidation from Floodwall Construction
		inches
Sunnyvale East	Confluence - Caribbean	1 to 6
	Caribbean – Hwy 237	1 to 3
	Hwy 237 - Tasman	0.5 to 2
	Tasman – Hwy 101	0.5 to 3
	Duane - Wolfe	1 to 4
	Evelyn to STA 199+92	1 to 4
Sunnyvale West	Confluence – Carl	1 to 3
	Carl – Caribbean	1 to 3
	Caribbean – Java	1 to 3
	Java - Bordeaux	1 to 3
	Bordeaux - Mathilda	1 to 3

    - Locations along the channels requiring floodwalls will be pre-loaded to account for settlement from both under-consolidation and primary consolidation. Cost estimates for this work have not been included at this phase of the project; however it is assumed that the 35% construction contingencies will cover this work.

Design Criteria for Levees (CPE 3)

This CPE would provide flood protection by creating new or raising existing levees (earthen barrier that contain flow within a channel) thereby increasing the overall channel capacity

- Levees will be built to have side slopes of 2:1 (horizontal: vertical)

- Settlement

    - Under-consolidated soils have been identified along Sunnyvale East Channel from the south side of Caribbean Drive to Highway 101. Settlement due to this under-consolidation is estimated to be between 10 to 14 inches.

    - Settlement due to primary consolidation from levee construction is estimated as follows:

Table A2. Estimated Settlement Due to Primary Consolidation from Levee Construction

Channel	Reach	Primary Consolidation from New Fill
		inches
Sunnyvale East	Confluence - Caribbean	2 to 12
	Caribbean – Hwy 237	2 to 12
	Hwy 237 - Tasman	1 to 6
	Tasman – Hwy 101	1 to 6
	Duane - Wolfe	1 to 4
	Evelyn to STA 199+92	1 to 4
Sunnyvale West	Confluence – Carl	18 to 36
	Carl – Java	0 to 12
	Java - Bordeaux	0 to 12
	Bordeaux - Mathilda	0 to 12

- Levees will be overbuilt to account for total settlement from both under-consolidation and primary consolidation.

Design Criteria for Detention Area (CPE 4)

This CPE would provide flood protection by diverting high flows during a flood event into a detention area and storing the water until the flood period is over.

- Water will enter detention area via an overflow weir and drain back to the channel through a piped outlet.

- Facility will drain within 72 hours after waters have receded in the channel.

Design Criteria for Erosion Protection (CPE 6)

This CPE would provide erosion protection and bank stability by using the rock toe protection method, which is suitable for the steep-banked (1.5:1-sloped) trapezoidal channel cross section found along Sunnyvale East and West Channels.

- Channel rocked to the 10-year flow level in non-tidal areas (per CPSD design manual) and the mean higher high water level in the tidal reaches.

Design Criteria for Pond A4 Flood Basin (CPE 7)

Construction of this element would involve realigning both channels to flow into Pond A4, which would serve as a flood basin, and installing tide gates and a slide gate along the existing levee between Pond A4 and Guadalupe Slough. Sunnyvale West channel would be routed to flow into Pond A4 at the location of its southwest corner. Sunnyvale East channel would be routed into Pond A4 at the location where it first intersects with the south side of Pond A4; this would eliminate its 90 degree bend. During wet weather, the flood basin would be designed to fill with flows from Sunnyvale East and West Channels and drain to Guadalupe Slough via its tide-gate connection during subsequent low tides. By disconnecting the channels from Guadalupe Slough, this CPE would significantly reduce the risk of flooding along the channels by removing them from both tidal influence and the effects of backwater flows originating from San Tomas Aquino and Calabazas Creeks.

- Pond A4 will be designed with capacity to receive the following inflow sources with a minimum of 1-foot of inboard freeboard; the design will include an analysis to ensure that these conditions are still met after sea level rise has occurred

    a. Simultaneous 100-year flow hydrographs on the Sunnyvale East and West Channel Watersheds that would result from a 24-hour storm.

    b. Constant inflow of 21.65 cfs from the City of Sunnyvale's Water Pollution Control Plant, which currently empties to Sunnyvale West Channel (and pumps at a continuous rate of about 21.65 cfs during both dry and wet weather)

    c. Inflow from Pump Station Number 1, which drains a part of northern Sunnyvale and empties to Sunnyvale West Channel (139 cfs continuously during the storm).

    d. Inflow from Lockheed Pump Station, which drains Lockheed's campus and Moffett Field (69 cfs continuously during the storm).

- The levees around Pond A4 will be designed to be higher than the 100-year tide with sea level rise.

- Pond A4 will be designed to have a managed pond level in-between storms which will provide adequate capacity to meet its inboard freeboard criteria.

- Pond A4 will be designed to have an average pond level close to the existing managed pond level of 1.05 ft NAVD88.

- Pond A4 will be designed so as not to restrict future work to provide tidal flood protection by the Shoreline Project or any future project.

- Pond A4 will drain within 72 hours after the end of the District’s simulated100-year flow hydrographs for the Sunnyvale East and West Channels which would result from a 24-hour storm.

- Pond A4 will be designed to prevent erosion problems around each constructed element.

- Pond A4 will minimize adverse impacts to existing habitat and water quality; improve if possible.

- The City of Sunnyvale’s water pollution control plant effluent pipeline will be re-routed via a siphon to flow into the remnant part of Sunnyvale West Channel, which runs along the north-west side of Pond A4.

3 Feasible Alternatives Details

3.1 Alternative A: No Project

Alternative Description

Under feasible alternative A, no new project elements would be implemented in the study area. Flood flows would continue to overtop channel banks and inundate adjacent properties, resulting in flood-related damages to residences and businesses. Current maintenance activities such as sediment removal, erosion repair, and vegetation maintenance would continue.

3.2 Alternative B: Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality. Feasible alternative B is composed of the following:

Sunnyvale East Channel

- CPE 2: Floodwalls

  The locations and heights of floodwalls are described below. References to the right and left banks assume that you are looking downstream.

  Reach E4 would be modified by the addition of floodwalls for a 260 ft length immediately upstream of Evelyn Ave. Reach E3 would be modified by the addition of floodwalls for a 150 ft length upstream of Blythe Ave, for a 100 ft length immediately upstream of Hwy 101, and for the entire length between Wolfe Rd. and Duane Ave. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the location where Sunnyvale East Channel turns to flow to the east. For the length downstream of this location to the confluence with Guadalupe Slough, the channel would be modified by the addition of floodwalls on the right bank only; levees would be raised on the left bank.

Table A3. Alternative B: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E4	260 ft reach extending upstream of Evelyn Ave.	4.5	4.5
E3	Wolfe Rd. to Duane Ave.	4.2	4.6
	150 ft reach extending upstream of Blythe Ave.	3.2	3.1
	100 ft length of channel extending upstream of Hwy 101	3.1	3.3
E2	Hwy 101 to Tasman Dr.	3.3	3.8
	Tasman Dr. to Hwy 237	2.3	2.6
	Hwy 237 to Caribbean Dr.	4.6	4.7
E1	Caribbean Dr. to S.F. Bay Shoreline	4.4	4.3
	S.F. Bay Shoreline to Confluence	See Table Below	4.3

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

Reach E1 would be modified between the location where Sunnyvale East Channel turns to flow to the east and the confluence with Guadalupe Slough by raising the existing levee along the right bank (adjacent to Pond A4). Raising levees would be preferable to constructing floodwalls at this location because it would tie into the existing levee around Pond A4 and blend into the landscape more readily.

Table A4. Alternative B: Levee Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E1	S.F. Bay Shoreline to Confluence	4.4	See table above

- CPE 6: Erosion Protection

  Sunnyvale East Channel experiences erosion problems along most of its 6 mile length, including slumping failures, toe erosion, and scour adjacent to hardscape features. The erosion problems are due to a combination of the channel's lack of an upstream sediment supply, inadequate floodplain width, multiple drop structures and culverts capable of inducing supercritical flow, and frequent alternation of hardscaped or lined sections of channel with natural channel. Although the channel's invert profile appears to have reached a state of quasi-equilibrium, it would be difficult for the channel cross section to evolve to (or to be designed to) a geomorphically stable state at most locations without the prohibitively expensive and time intensive acquisition of property.

  The table below describes the erosion problems and locations along Sunnyvale East Channel which have been identified by the project team as needing repair. For the purposes of the planning study and cost estimate, the project team has selected the rock toe bank slope protection method. This is an appropriate repair for the identified erosion problems, which occur in reaches with steep side slopes (1.5:1, H:V, or steeper) and velocities lower than 7 ft/sec. This method consists of protecting the toe and lower banks with rock up to the 10-year flow level and repairing the slope above this level with a combination of earth fill, erosion protection fabric, and hydroseed. However, as the project moves into its design phase, erosion repair methods will be customized to each repair site; where possible, the project team will adopt geomorphic design principles.

Table A5. Erosion Protection on Sunnyvale East Channel

All Alternatives: Erosion Protection on Sunnyvale East Channel				
Reach	Location	Description	Erosion Repair Dimensions**	
			Length (ft)	Height (ft)
E6	Dunholme Way to Carlise Way	Slumping failure (5 to 6 ft high) on both banks	600	3
	Ashbourne Dr. to Fremont Ave.	Slumping failure on east bank	35	4
E5	Fremont Ave. to Crescent Ave.	Scour at transitions between hardscape and natural banks	20	5
	Crescent Ave. to El Camino Real	Slumping failure on both banks	600	5
E3	Kifer Rd. to Pedestrian Bridge	Sack-concrete failure on west bank	62	4
	Arques Ave. to Wolfe Rd.	Toe erosion and slumping failure on the west bank	450	6
	Wolfe Rd. to Duane Ave.	Slumping failure and toe erosion on both banks, in between hardscape	325	7
	Blythe Ave. to Hwy 101	Slumping failure on west bank	194	7
		Slumping failure on east bank	177	7
		Slumping failure on east bank	199	6
E2	Hwy 101 to Tasman Dr.	Slumping failure east bank at 3 locations along this 600-ft length	600	9
		Slumping failure on east bank, in between hardscape	70	9
	Tasman Dr. to Hwy 237	Toe erosion (3 ft high) on west bank	854	10
** These dimensions describe the along-channel length of repair (typically shorter than the entire length of the reach) and the height of the repair (up to the 10-year water surface elevation)				

In addition, there is evidence of invert erosion at two locations in Reach E4 and one location in E2. These locations do not currently require repair, but should be monitored for further degradation after large storms.

Sunnyvale West Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W2 would be modified by the addition of floodwalls for the entire length between Mathilda Ave. and Bordeaux Dr. on the left bank and for a shorter length extending 500 feet upstream of Bordeaux Dr. on the right bank. The length between Bordeaux Dr. and Caribbean Dr. would be modified by the addition of floodwalls on both banks. Reach W1 would be modified by the addition of floodwalls between Caribbean Dr. and Carl Rd.

Table A6. Alternative B: Floodwall Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W2	Mathilda Ave. to Bordeaux Dr.	1.0	0.5
	Bordeaux Dr. to Java Dr.	3.0	3.0
	Java Dr. to Caribbean Dr.	4.0	4.3
W1	Caribbean Dr. to Carl Rd.	4.5	4.5

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

Table A7. Alternative B: Levee Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W1	Carl Rd. to S.F. Bay Shoreline	3.0	2.5
	S. F. Bay Shoreline to Confluence	0.5	NONE

Floodwall heights pertain to above ground elevations

Reach W1 would be modified by raising the existing levees on both banks between Carl Rd. and the San Francisco Bay Shoreline and by raising them on the left bank only between the San Francisco Bay Shoreline and the confluence with Guadalupe Slough.

- CPE 6: Erosion Protection

  Sunnyvale West Channel experiences erosion problems along much of its length, including localized slumping failures, long reaches of toe erosion, and scour adjacent to hardscape features. The erosion problems are primarily due to a combination of the channel's lack of an upstream sediment supply and inadequate floodplain width. Although the channel's invert profile appears to have reached a state of quasi-equilibrium, it would be difficult for the channel cross section to evolve to (or to be designed to) a geomorphically stable state at most locations without the prohibitively expensive and time intensive acquisition of property.

The table below describes the erosion problems and locations along Sunnyvale West Channel which have been identified by the project team as needing repair. For the purposes of the planning study and cost estimate, the project team has selected the rock toe bank slope protection method, as described above in the discussion of erosion problems along Sunnyvale East Channel. However, as the project moves into its design phase, erosion repair methods will be customized to each repair site; where possible, the project team will adopt geomorphic design principles.

Table A8. Erosion Protection on Sunnyvale West Channel

All Alternatives: Erosion Protection on Sunnyvale West Channel				
Reach	Location	Description	Erosion Repair Dimensions**	
			Length (ft)	Height (ft)
W4	Parking Lot Culvert to Highway 101	Toe erosion (3 to 4 ft high) along outside bend of the east bank	210	5.23
	Highway 101 to Ross Dr.	Toe erosion (4 to 5 ft high) near gunny sack on east bank	50	4.30
		Minor slumping failure on west bank	30	4.95
W2	Mathilda Ave. to Bordeaux Dr.	Toe erosion on both banks	817	5.65
	Bordeaux Dr. to Java Dr.	Toe erosion and slumping failure on both banks	1872	6.15
	Java Dr. to Caribbean Dr.	Toe erosion and slumping failure on both banks	1852	6.77
W1	Caribbean Dr. to Carl Rd.	Toe erosion and slumping failure on west bank	300	7.05
** These dimensions describe the along-channel length of repair (typically shorter than the entire length of the reach) and the height of the repair (up to the 10-year water surface elevation)				

In addition, here is evidence of invert erosion at two locations in Reach W4 and one location in W2. The locations in Reach W4 do not currently require repair, but should be monitored for further degradation after large storms.

Land Ownership/Access

It is expected that strips of land from 9 parcels on Sunnyvale East Channel and 12 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative B; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of residential properties (backyards and parking), commercial properties (parking), parks and recreation facilities (Fair Oaks Park and Twin Creeks Softball Complex), the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr, and public road property (parking and a thin strip of Holly Terrace).

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A9. Alternative B: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E4	Immediately upstream of Evelyn Ave.	5	21	NONE
E3	Wolfe Rd. to Duane Ave.	7	9	
	Immediately upstream of Blythe Ave.	11	0	
	Immediately upstream of Hwy 101	0	0	
E2	Hwy 101 to Tasman Dr.	0	8	
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to S.F. Bay Shoreline	0	0	
	S.F. Bay Shoreline to Confluence	35	3	

Table A10. Alternative B: Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	8	3	NONE
	Bordeaux Dr. to Java Dr.	2	6	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to S.F. Bay Shoreline	26	13	
	S. F. Bay Shoreline to Confluence	138	0	

3.3 Alternative D: Detention Areas, Floodwalls, and Erosion Projection

Alternative Description

This alternative combines detention, floodwalls, and erosion protection elements to increase the capacity of all the project reaches to the design flow, provide channel stability, and improve water quality. Feasible Alternative D is composed of the following:

Sunnyvale East Channel

- CPE 4: Detention

  An off-stream detention facility would be built at Braly Park which is owned by the City of Sunnyvale. The detention facility would be built below ground with the approximate dimension of 660 feet wide and 260 feet long at a depth of 8 feet and 3:1 side slopes. Braly Park would provide approximately 28 acre-feet of detention and would be inundated every 7-8 years.

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  The detention facilities remove the need for floodwalls upstream of Hwy 101 (Reaches E3, E4, E5, and E6) and reduce the height of the floodwalls required downstream of Hwy 101 (Reaches E2 and E1). Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the location where Sunnyvale East Channel turns to flow to the east. For the length downstream of this location to the confluence with Guadalupe Slough, the channel would be modified by the addition of floodwalls on the right bank only; levees would be raised on the left bank.

Table A11. Alternative D: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E2	Hwy 101 to Tasman Dr.	2.8	3.2
	Tasman Dr. to Hwy 237	2.1	2.4
	Hwy 237 to Caribbean Dr.	4.4	4.5
E1	Caribbean Dr. to S.F. Bay Shoreline	4.4	4.3
	S.F. Bay Shoreline to Confluence	See table below	4.3

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

Table A12. Alternative D: Levee Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E1	S.F. Bay Shoreline to Confluence	4.4	See table above

Freeboard deficiencies heights pertain to above ground elevations

Reach E1 would be modified between the location where Sunnyvale East Channel turns to flow to the east and the confluence with Guadalupe Slough by raising the existing levee along the right bank (adjacent to Pond A4). Raising levees would be preferable to constructing floodwalls at this location because it would tie into the existing levee around Pond A4 and blend into the landscape more readily.

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 4: Detention

  There is only one suitable detention site located along Sunnyvale West Channel and it is too small to significantly reduce flood flows. Therefore, the project team recommends not constructing a detention facility on Sunnyvale West Channel.

- CPE 2: Floodwalls

  The floodwall protection element for this alternative is the same as described in feasible alternative B.

- CPE 3: Levees

  The levees protection element for this alternative is the same as described in feasible alternative B.

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

It is expected that strips of land from 2 parcels on Sunnyvale East Channel and 12 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative D; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of the Twin Creeks Softball Complex and the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr. In addition, the District would pursue a joint use agreement with the City of Sunnyvale for 4 acres of land at Braly Park for the construction of the planned off-stream detention basin.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A13. Alternative D: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E2	Hwy 101 to Tasman Dr.	0	9	NONE
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to S.F. Bay Shoreline	0	0	
	S.F. Bay Shoreline to Confluence	35	3	

Table A14. Alternative D: Average Widths of Land Acquisition along Sunnyvale West Channel (same as Alternative B)

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	8	3	NONE
	Bordeaux Dr. to Java Dr.	2	6	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to S.F. Bay Shoreline	26	13	
	S. F. Bay Shoreline to Confluence	138	0	

3.4 Alternative H: Pond A4, Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines Pond A4, floodwalls, levees and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality. Feasible Alternative H is composed of the following:

Pond A4

- CPE 7: Pond A4

  Sunnyvale East Channel and Sunnyvale West Channel would both be re-routed to flow into Pond A4. Pond A4 would be used as a flood detention basin for temporary storage of flood waters and would be connected to Guadalupe Slough by 1 slide gate and 5 tide gates. The slide gate would remain open under normal conditions, but would be closed during storm events, allowing the pond to function as a detention basin for storage of storm water. The pond would drain via the tide gates during subsequent low tides. The levees around Pond A4 would be raised to a minimum finished elevation of 12 ft NAVD88: by 1 to 2 feet along the south side of Pond A4 for a distance of about 2900 ft (between the channels) and by 1 ft along the northeast side of Pond A4 for a distance of about 900 ft (close to the location where the tide would be installed).

Sunnyvale East Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach E4 would be modified by the addition of floodwalls for a 160 ft length immediately upstream of Evelyn Ave. Reach E3 would be modified by the addition of floodwalls for a 150 ft length upstream of Blythe Ave, for a 100 ft length immediately upstream of Hwy 101, and for the entire length between Wolfe Rd. and Duane Ave. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the new connection of Sunnyvale East Channel with Pond A4.

Table A15. Alternative H: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E4	160 ft reach extending upstream of Evelyn Ave.	4.0	4.2
E3	Wolfe Rd. to Duane Ave.	4.0	4.4
	150 ft reach extending upstream of Blythe Ave.	3.2	3.1
	100 ft length of channel extending upstream of Hwy 101	3.1	3.2
E2	Hwy 101 to Tasman Dr.	3.1	3.5
	Tasman Dr. to Hwy 237	1.9	2.1
	Hwy 237 to Caribbean Dr.	3.5	3.6
E1	Caribbean Dr. to Pond A4 Connection	1.8	1.6

Floodwall heights pertain to above ground elevations

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W2 would be modified by the addition of floodwalls for the entire length between Mathilda Ave. and Bordeaux Dr. on the left bank only. The length between Bordeaux Dr. and Caribbean Dr. would be modified by the addition of floodwalls on both banks. Reach W1 would be modified by the addition of floodwalls between Caribbean Dr. and Carl Rd.

Table A16. Alternative H: Floodwall Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W2	Mathilda Ave. to Bordeaux Dr.	1	NONE
	Bordeaux Dr. to Java Dr.	1.7	1.7
	Java Dr. to Caribbean Dr.	2.6	2.7
W1	Caribbean Dr. to Carl Rd.	3.2	3.3

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W1 would be modified by raising the existing levees on both banks between Carl Rd. and the new connection with Pond A4 and Sunnyvale West Channel.

Table A17. Alternative H: Levee Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W1	Carl Rd. to Pond A4 Connection	1.9	1.9

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

It is expected that strips of land from 9 parcels on Sunnyvale East Channel and 7 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative H; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of residential properties (backyards and parking), commercial properties (parking), parks and recreation facilities (Fair Oaks Park), the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr, and public road property (parking and a thin strip of Holly Terrace).

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A18. Alternative H: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E4	Immediately upstream of Evelyn Ave.	5	23	NONE
E3	Wolfe Rd. to Duane Ave.	7	13	
	Immediately upstream of Blythe Ave.	11	0	
	Immediately upstream of Hwy 101	0	0	
E2	Hwy 101 to Tasman Dr.	0	9	
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to Pond A4 Connection	0	0	

Table A19. Alternative H: Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	6	0	NONE
	Bordeaux Dr. to Java Dr.	2	5	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to Pond A4 Connection	25	6	

3.5 Alternative I: Pond A4, Levees, and Erosion Protection

Alternative Description

This alternative combines Pond A4, levees, and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality. Feasible Alternative I is composed of the following:

Pond A4

- CPE 7: Pond A4
  The Pond A4 element for this alternative is the same as described in feasible alternative H.

Sunnyvale East Channel

- CPE 3: Levees
  Levees (instead of floodwalls) would be constructed at the same locations and to the same heights as outlined for Alternative H.

- CPE 6: Erosion Protection
  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 3: Levees
  Levees (instead of floodwalls) would be constructed at the same locations and to the same heights as outlined for Alternative H.

- CPE 6: Erosion Protection
  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

Alternative I requires the most land acquisition of all alternatives because it uses levees to provide flood protection along its entire length. It is expected that strips of land from 22 parcels on Sunnyvale East Channel and 21 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative I; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of residential properties (including more than 57 houses, backyards and parking), commercial properties (parking), parks and recreation facilities (Fair Oaks Park and Twin Creeks Softball Complex), the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr, and public road property (parking along and half the width of Holly Terrace and part of Britton Ave.).

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A20. Alternative I: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E4	Immediately upstream of Evelyn Ave.	11	30	0
E3	Wolfe Rd. to Duane Ave.	31	21	0
	Immediately upstream of Blythe Ave.	32	3	2
	Immediately upstream of Hwy 101	21	8	1
E2	Hwy 101 to Tasman Dr.	24	26	38
	Tasman Dr. to Hwy 237	10	15	19
	Hwy 237 to Caribbean Dr.	24	17	0
E1	Caribbean Dr. to Pond A4 Connection	0	11	0

Table A21. Alternative I: Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	9	17	NONE
	Bordeaux Dr. to Java Dr.	3	11	
	Java Dr. to Caribbean Dr.	5	5	
W1	Caribbean Dr. to Carl Rd.	6	15	
	Carl Rd. to Pond A4 Connection	22	11	

3.6 Alternative J: Pond A4, Detention Areas, Floodwalls, Levees and Erosion Protection

Alternative Description
This alternative combines Pond A4, detention, floodwalls, levees and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality. Feasible Alternative J is composed of the following:

Pond A4

- CPE 7: Pond A4

  The Pond A4 element for this alternative is the same as described in feasible alternative H.

Sunnyvale East Channel

- CPE 4: Detention

  An off-stream detention facility would be built at Braly Park which is owned by the City of Sunnyvale. The detention facility would be built below ground with the approximate dimension of 660 feet wide and 260 feet long at a depth of 8 ft and 3:1 side slopes. Braly Park would provide approximately 28 acre-ft of detention and would be inundated every 7-8 years.

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  The detention facility removes the need for floodwalls upstream of Highway 101 (Reaches E4, E5, and E6) and reduces the height of the floodwalls required downstream of Highway 101. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the new connection of Sunnyvale East Channel with Pond A4.

Table A22. Alternative J: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E2	Hwy 101 to Tasman Dr.	2.5	3
	Tasman Dr. to Hwy 237	1.5	1.8
	Hwy 237 to Caribbean Dr.	3.3	3.4
E1	Caribbean Dr. to Pond A4 Connection	1.7	1.6

Floodwall heights pertain to above ground elevations

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 4: Detention

  There is only one suitable detention site located along Sunnyvale West Channel and it is too small to significantly reduce flood flows. Therefore, the project team recommends not constructing a detention facility on Sunnyvale West Channel.

- CPE 2: Floodwalls

  The floodwall protection element for this alternative is the same as described in feasible alternative H.

- CPE 3: Levees

  The levees protection element for this alternative is the same as described in feasible alternative H.

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

Alternative J requires the least amount of land acquisition of all alternatives because it combines all project elements. It is expected that strips of land from 2 parcels on Sunnyvale East Channel and 7 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative J; average land strip widths are itemized by location in the tables below.

Along Sunnyvale East Channel, acquired lands could include portions of the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr. In addition, the District would pursue a joint use agreement with the City of Sunnyvale for 4 acres of land at Braly Park for the construction of the planned off-stream detention basin.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A23. Alternative J: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E2	Hwy 101 to Tasman Dr.	0	9	None
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to Pond A4 Connection	0	0	

Table A24. Alternative J: Average Widths of Land Acquisition along Sunnyvale West Channel (same as Alternative H)

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	6	0	NONE
	Bordeaux Dr. to Java Dr.	2	5	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to Pond A4 Connection	25	6	

3.7 Alternative K: Pond A4, Detention, Levees, and Erosion Protection

Alternative Description
This alternative combines Pond A4, detention, levees, and erosion protection elements to increase the capacity of the project reaches to the design flow, provide channel stability, and improve water quality (Figure 7). Feasible alternative K is composed of the following:

Pond A4

- CPE 7: Pond A4
  The Pond A4 element for this alternative is the same as described in feasible alternative H.

Sunnyvale East Channel

- CPE 4: Detention
  An off-stream detention facility would be built at Braly Park which is owned by the City of Sunnyvale. The detention facility would be built below ground with the approximate dimension of 660 feet wide and 260 feet long at a depth of 8 ft and 3:1 side slopes. Braly Park would provide approximately 28 acre-ft of detention and would be inundated every 7-8 years.

- CPE 3: Levees
  Levees (instead of floodwalls) would be constructed at the same locations and to the same heights as outlined for Alternative I.

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- CPE 6: Erosion Protection
  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 4: Detention
  There is only one suitable detention site located along Sunnyvale West Channel and it is too small to significantly reduce flood flows. Therefore, the project team recommends not constructing a detention facility on Sunnyvale West Channel.

- CPE 3: Levees
  Levees (instead of floodwalls) would be constructed at the same locations and to the same heights as outlined for Alternative I.

- CPE 6: Erosion Protection
  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

It is expected that strips of land from 11 parcels on Sunnyvale East Channel and 21 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative J; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of residential properties (including more than 57 houses and parking), commercial properties (parking), parks and recreation facilities (Twin Creeks Softball Complex),and the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr. In addition, the District would pursue a joint use agreement with the City of Sunnyvale for 4 acres of land at Braly Park for the construction of the planned off-stream detention basin.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A25. Alternative K: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E2	Hwy 101 to Tasman Dr.	21	23	38
	Tasman Dr. to Hwy 237	9	14	19
	Hwy 237 to Caribbean Dr.	23	16	0
E1	Caribbean Dr. to S.F. Bay Shoreline	0	11	0

Table A26. Alternative K: Average Widths of Land Acquisition along Sunnyvale West Channel (same as Alternative I)

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	9	17	NONE
	Bordeaux Dr. to Java Dr.	3	11	
	Java Dr. to Caribbean Dr.	5	5	
W1	Caribbean Dr. to Carl Rd.	6	15	
	Carl Rd. to Pond A4 Connection	22	11	

4 Top Three Alternative Details

The purpose of this section is to provide full details of the elements which make up each of the selected top three alternatives selected through the Natural Flood Protection evaluation procedure. Specifically, for each alternative, descriptions are provided for floodwall locations and heights, levee locations and heights, and locations and widths of expected right-of-way acquisition, and erosion protection elements. The detailed descriptions of the top three selected alternatives differ from those of the feasible alternatives because of changes to their design criteria.

4.1 Refined Design Criteria for Top Three Selected Alternatives

This section documents differences in design criteria used for development of the feasible alternatives and those used for further development and analysis of the top three selected alternatives identified through the natural flood protection (NFP) process. As part of the transition from the planning to design phases of the project, the project team performed additional research to refine the design criteria to aid in selection of the staff recommended alternative. Specifically, the project team sought to refine:

1) required right-of-way acquisition,
2) estimates of pumped flows into Sunnyvale West Channel, and
3) estimates of the design capacity for Pond A4.

Changes to the design criteria are documented here; all other design criteria for development of the top three alternatives are identical to those listed in Section 2 of this appendix.

In addition to changes to the design criteria, it should be noted there was a significant increase to the starting water surface elevation used for Sunnyvale West Channel for Alternative B, which increased by 0.45 feet (from 11.6 ft NAVD88 to 12.05 ft NAVD88), and a smaller increase of 0.05 feet to that for Sunnyvale East Channel. Although these increases were due in part to changes to the design flows that are pumped into Sunnyvale West Channel (discussed below), the increase to the starting water level for Sunnyvale West Channel seems surprisingly large. The project team is currently investigating why the increase was so large – one possible explanation might be due to the version of the HEC-RAS software used to generate the newer values (version 4.0 versus 3.1.3). The project team decided to use the values generated with the updated version of HEC-RAS software because it provided more conservative estimates of the starting water surface elevations.

[Note that the starting water surface elevations for all alternatives were determined with an unsteady HEC-RAS model of the network of channels (only up to their limit of tidal influence) including Sunnyvale East Channel, Sunnyvale West Channel, Calabazas Creek, San Tomas Aquino Creek, Alviso Slough, and Coyote Creek out to the Bay. Values generated from this model and appropriate flow assumptions for each alternative were used as the downstream boundary conditions for the steady state HEC-RAS models for Sunnyvale East and West Channels, which were in turn used to define the base flood water surface profiles along each channel.]

Changes to the General Design Criteria

There are two changes to the general design criteria: one regarding the design flow distribution along Sunnyvale West Channel and the other regarding the minimum required maintenance road widths. These changes are described below.

Changes to Maintenance Road Width Requirements (for determining required ROW acquisition)

The required width of maintenance roads will be determined independently for each site by consulting maintenance employees for actual needs. At some locations, maintenance roads will be maintained at a minimum width of 15-feet with a minimum width of 22-feet near road crossings to allow turning access for cranes with outriggers (i.e., some reaches will be designed to the same standards as used for the feasible alternatives). However, there are some locations where narrower roads may be allowed. In general:

- For reaches with existing maintenance roads on both banks, the project team may eliminate the maintenance road on one of the banks.
- For reaches where there is very low risk of large debris or trees entering the channel, the project team may maintain a minimum maintenance road width of 10 feet instead of 15.

Changes to the Design Flow along Sunnyvale West Channel for Alternative B

The design flow for Sunnyvale West Channel is a combination of a HEC-2 generated 100-year flow distribution for the upper parts of the watershed and the inflows from three additional sources- two pump stations which drain northern portions of the City of Sunnyvale (Lockheed Pump Station, Pump Station Number 1) and the City of Sunnyvale's Water Pollution Control Plant, all of which discharge into Sunnyvale West at locations near the southwest corner of Pond A4. For Alternative B (the only one of the top three which does not involve Pond A4), the flows pumped into the channel were adjusted as follows: WPCP flow was increased from 21.65 cfs to 61.9 cfs (based on new information from the City of Sunnyvale regarding pumping rates during storms); Pump Station Number 1 flow was decreased from 139 cfs to 104.72 cfs (see discussion in the table below); Lockheed Pump Station was reduced from 69 cfs to 20 cfs (see discussion in the table below).

Changes to the Design Criteria for Pond A4 Flood Basin

The only changes to the design criteria for the Pond A4 flood basin are to the assumed inflows coming from the City of Sunnyvale's WPCP facility, the City of Sunnyvale's Pump Station Number 1 and Lockheed Martin's pump station; they are listed in the table below.

Table A27. Changes to Design Flow Criteria for Pond A4

	Feasible Alternatives Design Flow	SRAR Design Flow	Reason for Change to Design Criteria
WPCP	Constant rate of 21.65 cfs during both dry- and wet-weather conditions	No inflow to Pond A4 during wet or dry weather. The WPCP discharge pipe would be extended to flow directly into Guadalupe Slough via the remnant channel on Sunnyvale West located along the northwest boundary of Pond A4.	The existing WPCP discharge permit (expiring in 2014) would be invalidated and costly to reinstate if WPCP flows were re-routed to flow into Pond A4. At stake are dilution credits currently received for cyanide.
Pump Station No. 1	Constant flow rate of 139 cfs during wet weather; zero during dry weather.	Constant rate of 104.72 cfs during wet weather; zero during dry weather.	The project team received documentation of the 2008 renovation of Pump Station No. 1. In addition, communication with City employees revealed that the smallest of the three updated pumps (with a capacity of 17 cfs) would not run simultaneously with the other two (total capacity 104.72 cfs).
Lockheed Pump Station	Constant rate of 69 cfs during wet weather; zero during dry weather	Constant rate of 20 cfs during wet weather; zero during dry weather	The Lockheed pump station cannot pump at its maximum capacity of 69 cfs when water levels in its receiving channel are high; Lockheed employees recommended we use a constant rate of 20 cfs during storms in our design.

4.2 Refined Alternative B: Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to contain the design flow, to provide channel stability, and to improve water quality. Refined feasible Alternative B is composed of the following:

Sunnyvale East Channel

- CPE 2: Floodwalls

  The locations and heights of floodwalls are described below. References to the right and left banks assume that you are looking downstream (i.e., north).

  Reach E4 would be modified by the addition of floodwalls for a 260 ft length immediately upstream of Evelyn Ave. Reach E3 would be modified by the addition of floodwalls for the entire length between Wolfe Rd. and Duane Ave. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the location where Sunnyvale East Channel turns to flow to the east. For the length downstream of this location to the confluence with Guadalupe Slough, the channel would be modified by the addition of floodwalls on the right bank only; levees would be raised on the left bank.

Table A28. Refined Alternative B: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E4	260 ft reach extending upstream of Evelyn Ave.	4.50	5.50
E3	Wolfe Rd. to Duane Ave.	0.50	3.50
E2	Hwy 101 to Tasman Dr.	3.50	4.00
	Tasman Dr. to Hwy 237	2.50	2.50
	Hwy 237 to Caribbean Dr.	4.50	5.00
E1	Caribbean Dr. to S.F. Bay Shoreline	4.50	4.50
	S.F. Bay Shoreline to Confluence	See table below	4.50

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach E1 would be modified between the location where Sunnyvale East Channel turns to flow to the east and the confluence with Guadalupe Slough by raising the existing levee along the right bank (adjacent to Pond A4). Raising levees would be preferable to constructing floodwalls at this location because it would tie into the existing levee around Pond A4 and blend into the landscape more readily.

Table A29. Refined Alternative B: Levee Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E1	S.F. Bay Shoreline to Confluence	5	See table above

- CPE 6: Erosion Protection

  Bank and toe erosion repairs are needed in reaches E6 (two locations), E5 (two locations), E4 (one location), E3 (six locations), and E2 (three locations) on Sunnyvale East Channel. The rock toe bank slope protection method has been selected due to the steep side slopes (1.5:1, H:V, or steeper) and maximum velocity calculated (7 ft/sec and below) in the channel. This method consists of protecting the toe and lower banks (up to the 10 year flow level) with rock and repairing the slope above this level with a combination of earth fill, erosion protection fabric, and hydroseed.

  There is evidence of invert erosion at two locations in Reach E4 and one location in E2. These locations do not currently require repair, but should be monitored for further degradation after large storms.

Sunnyvale West Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W2 would be modified by the addition of floodwalls for the entire length between Mathilda Ave. and Bordeaux Dr. on the left bank and for a shorter length extending 500 feet upstream of Bordeaux Dr. on the right bank. The length between Bordeaux Dr. and Caribbean Dr. would be modified by the addition of floodwalls on both banks. Reach W1 would be modified by the addition of floodwalls between Caribbean Dr. and Carl Rd.

Table A30. Refined Alternative B: Floodwall Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W2	Mathilda Ave. to Bordeaux Dr.	1	0.5
	Bordeaux Dr. to Java Dr.	3.5	3.5
	Java Dr. to Caribbean Dr.	4.5	4.5
W1	Caribbean Dr. to Carl Rd.	5	5

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

Table A31. Refined Alternative B: Levee Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W1	Carl Rd. to S.F. Bay Shoreline	3.5	4.5
	S. F. Bay Shoreline to Confluence	2	1

Reach W1 would be modified by raising the existing levees on both banks between Carl Rd. and the San Francisco Bay Shoreline and by raising them on the left bank only between the San Francisco Bay Shoreline and the confluence with Guadalupe Slough.

- CPE 6: Erosion Protection

  Bank and toe erosion repairs are needed in reaches W4 (two locations), W2 (two locations), and W1 (one location). The rock toe bank slope protection method has been selected due to the steep side slopes (1.5:1, H:V, or steeper) and maximum velocity calculated (7 ft/sec and below) in the channel. This method consists of protecting the toe and lower banks (up to the 10 year flow level) with rock and repairing the slope above this level with a combination of earth fill, erosion protection fabric, and hydroseed.

  There is evidence of invert erosion at two locations in Reach W4 and one location in W2. The locations in Reach W4 do not currently require repair, but should be monitored for further degradation after large storms.

Land Ownership/Access

It is expected that strips of land from 3 parcels on Sunnyvale East Channel and 11 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative B; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could portions of commercial properties (parking), parks and recreation facilities (Fair Oaks Park), and the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A32. Refined Alternative B: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E4	Immediately upstream of Evelyn Ave.	0	0	NONE
E3	Wolfe Rd. to Duane Ave.	3	12	
E2	Hwy 101 to Tasman Dr.	0	7	
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to S.F. Bay Shoreline	0	0	
	S.F. Bay Shoreline to Confluence	0	0	

Table A33. Refined Alternative B: Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	15.2	2.3	NONE
	Bordeaux Dr. to Java Dr.	0	5.2	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to S.F. Bay Shoreline	28	12	
	S. F. Bay Shoreline to Confluence	136	0	

4.3 Refined Alternative H: Pond A4, Floodwalls, Levees and Erosion Protection

Alternative Description

This alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to contain the design flow, to provide channel stability, and to improve water quality. Refined feasible alternative H is composed of the following:

Pond A4

- CPE 7: Pond A4

  Sunnyvale East Channel and Sunnyvale West Channel would both be re-routed to flow into Pond A4. Pond A4 would be used as a flood detention basin for temporary storage of flood waters and would be connected to Guadalupe Slough by 1 slide gate and 5 tide gates. The slide gate would remain open under normal conditions, but would be closed during storm events, allowing the pond to function as a detention basin for storage of storm water. The pond would drain via the tide gates during subsequent low tides. The levees around Pond A4 would be raised to a minimum finished elevation of 12 ft NAVD88: by 1 to 2 feet along the south side of Pond A4 for a distance of about 2900 ft (between the channels) and by 1 ft along the northeast side of Pond A4 for a distance of about 900 ft (close to the location where the tide would be installed).

Sunnyvale East Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach E4 would be modified by the addition of floodwalls for a 160 ft length immediately upstream of Evelyn Ave. Reach E3 would be modified by the addition of floodwalls for the entire length between Wolfe Rd. and Duane Ave. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the new connection of Sunnyvale East Channel with Pond A4.

Table A34. Refined Alternative H: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E4	160 ft reach extending upstream of Evelyn Ave.	4.5	5.5
E3	Wolfe Rd. to Duane Ave.	4	4.5
E2	Hwy 101 to Tasman Dr.	3.5	3.5
	Tasman Dr. to Hwy 237	2	2
	Hwy 237 to Caribbean Dr.	3.5	4
E1	Caribbean Dr. to Pond A4 Connection	1.5	1.5

Floodwall heights pertain to above ground elevations

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W2 would be modified by the addition of floodwalls for the entire length between Mathilda Ave. and Bordeaux Dr. on the left bank only. The length between Bordeaux Dr. and Caribbean Dr. would be modified by the addition of floodwalls on both banks. Reach W1 would be modified by the addition of floodwalls between Caribbean Dr. and Carl Rd.

Table A35. Alternative H: Floodwall Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W2	Mathilda Ave. to Bordeaux Dr.	1	0
	Bordeaux Dr. to Java Dr.	1.5	1.5
	Java Dr. to Caribbean Dr.	2	2
W1	Caribbean Dr. to Carl Rd.	2	2

Floodwall heights pertain to above ground elevations

- CPE 3: Levees

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  Reach W1 would be modified by raising the existing levees on both banks between Carl Rd. and the new connection with Pond A4 and Sunnyvale West Channel.

Table A36. Alternative H: Levee Heights on Sunnyvale West Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
W1	Carl Rd. to Pond A4 Connection	1	1

Floodwall heights pertain to above ground elevations

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

It is expected that strips of land from 3 parcels on Sunnyvale East Channel and 3 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative H; average land strip widths are itemized by location in the table below.

Along Sunnyvale East Channel, acquired lands could include could commercial properties (parking), parks and recreation facilities (Fair Oaks Park), and the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A37. Alternative H: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E4	Immediately upstream of Evelyn Ave.	0	0	NONE
E3	Wolfe Rd. to Duane Ave.	3	10	
E2	Hwy 101 to Tasman Dr.	0	7	
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to Pond A4 Connection	0	0	

Table A38. Alternative H: Average Widths of Land Acquisition along Sunnyvale West Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	6	0	NONE
	Bordeaux Dr. to Java Dr.	0	0	
	Java Dr. to Caribbean Dr.	0	0	
W1	Caribbean Dr. to Carl Rd.	0	0	
	Carl Rd. to Pond A4 Connection	13	5	

4.4 Refined Alternative J: Pond A4, Detention Areas, Floodwalls, Levees and Erosion Protection

Alternative Description
This alternative combines floodwalls, levees, and erosion protection elements to increase the capacity of all the project reaches to contain the design flow, to provide channel stability, and to improve water quality. Refined feasible alternative J is composed of the following:

Pond A4

- CPE 7: Pond A4

  The Pond A4 element for this alternative is the same as described in feasible alternative H.

Sunnyvale East Channel

- CPE 4: Detention

  An off-stream detention facility would be built at Braly Park which is owned by the City of Sunnyvale. The detention facility would be built below ground with the approximate dimension of 660 feet wide and 260 feet long at a depth of 8 ft and 3:1 side slopes. Braly Park would provide approximately 28 acre-ft of detention and would be inundated every 7-8 years.

- CPE 2: Floodwalls

  The locations and heights are described below. References to the right and left banks assume that you are looking downstream.

  The detention facility removes the need for floodwalls upstream of Highway 101 (Reaches E4, E5, and E6) and reduces the height of the floodwalls required downstream of Highway 101. Reach E2 would be modified by the addition of floodwalls along its entire length, extending between Tasman Dr and Caribbean Dr. Reach E1 would be modified by the addition of floodwalls for the length between Caribbean Dr. and the new connection of Sunnyvale East Channel with Pond A4.

Table A39. Alternative J: Floodwall Heights on Sunnyvale East Channel

Reach	Location	Left Bank Height (ft)	Right Bank Height (ft)
E2	Hwy 101 to Tasman Dr.	3	3
	Tasman Dr. to Hwy 237	1.5	2
	Hwy 237 to Caribbean Dr.	3.5	3.5
E1	Caribbean Dr. to Pond A4 Connection	1.5	1.5

Floodwall heights pertain to above ground elevations

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Sunnyvale West Channel

- CPE 4: Detention

  There is only one suitable detention site located along Sunnyvale West Channel and it is too small to significantly reduce flood flows. Therefore, the project team recommends not constructing a detention facility on Sunnyvale West Channel.

- CPE 2: Floodwalls

  The floodwall protection element for this alternative is the same as described in feasible alternative H.

- CPE 3: Levees

  The levees protection element for this alternative is the same as described in feasible alternative H.

- CPE 6: Erosion Protection

  The erosion protection element for this alternative is the same as described in feasible alternative B.

Land Ownership/Access

Alternative J requires the least amount of land acquisition of all alternatives because it combines all project elements. It is expected that strips of land from 1 parcel on Sunnyvale East Channel and 2 parcels on Sunnyvale West Channel would need to be acquired by the District in fee or easement for the construction of Alternative J; average land strip widths are itemized by location in the tables below.

Along Sunnyvale East Channel, acquired lands could include portions of the open space property owned by the City of Sunnyvale located on the East bank between Hwy 101 and Tasman Dr. In addition, the District would pursue a joint use agreement with the City of Sunnyvale for 4 acres of land at Braly Park for the construction of the planned off-stream detention basin.

Along Sunnyvale West Channel, acquired lands could include portions of commercial properties (parking), the landfill property for the City of Sunnyvale and the Water Pollution Control Plant property. It is not anticipated that the operations of the City of Sunnyvale's public utilities would be impacted.

Table A40. Alternative J: Average Widths of Land Acquisition along Sunnyvale East Channel

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
E2	Hwy 101 to Tasman Dr.	0	7	None
	Tasman Dr. to Hwy 237	0	0	
	Hwy 237 to Caribbean Dr.	0	0	
E1	Caribbean Dr. to Pond A4 Connection	0	0	

Table A41. Alternative J: Average Widths of Land Acquisition along Sunnyvale West Channel (same as Alternative H)

Reach	Location	Left Bank Width (ft)	Right Bank Width (ft)	Anticipated number of Homes Impacted
W2	Mathilda Ave. to Bordeaux Dr.	6	0	NONE
	Bordeaux Dr. to Java Dr.	2	0	
	Java Dr. to Caribbean Dr.	0	2	
W1	Caribbean Dr. to Carl Rd.	2	3	
	Carl Rd. to Pond A4 Connection	12	6	

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Santa Clara Valley Water District℠

Sunnyvale East Channel and Sunnyvale West Channel Flood Protection Project

Planning Study Report

Appendix B

Cost Estimates

June 2010

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1 Introduction

The cost estimates for the Sunnyvale East and West Channels Flood Protection Project are broken into two components, capital and operations-maintenance costs. Details of the each of these components are summarized in this appendix.

2 Capital Costs

Capital costs are separated into two categories, construction and land acquisition. This section provides information on how the unit cost for both construction and land acquisition were calculated and summaries of the total capital cost for each alternative. Information on how the quantities were calculated can be found in the project working files.

2.1 Capital Unit Costs

2.1.1 Construction Unit Costs

The construction cost estimates were prepared using a combination of methods including parametric cost estimating, analogous cost estimating and quotes from vendors and District staff. The unit costs used in the estimates can be seen below (Table B1).

Table B1. Construction Unit Costs

Item	Unit	2010 Dollars
Excavation	CY	$ 28
Disposal of Excess Material	TON	$ 48
Fill	CY	$ 18
Concrete	CY	$ 1,040
Clear and Grub	ACRE	$ 13,223
Hydroseed	ACRE	$ 3,329
1/4 Ton Rock	TON	$ 61
Erosion Control Fabric	SF	$ 7
Geotextile	SF	$ 12
Piles	LF	$ 48
Piles Installation	EA	$ 3,411
Tide Gate	EA	$ 46,981
Slide Gate	EA	$ 67,333
Tennis Courts	EA	$ 64,200
Play Structure	EA	$ 40,072
Prefabricated Bridge	EA	$ 94,727
Bridge Installation	EA	$ 47,364
Erosion Control-Sunnyvale East Channel	LS	$ 2,188,210
Erosion Control - Sunnyvale West Channel	LS	$ 3,627,183
48" Reinforced Concrete Pipe	LF	$ 208

Parametric cost estimating, based on projects with similar bid items constructed by the District since 2001, was used to determine the following unit costs for excavation, disposal of excess material, fill, concrete, clearing and grubbing, and ¼ ton rock. The average bid received for each item was calculated and then a 7% per year escalation factor (FY10 Construction Cost Escalation Recommendation by Mike Munson) was applied to estimate the costs for the year 2010. Unit costs from the following projects were used:

- Lower Silver Creek 1-2 Channel Improvements from Coyote Creek to McKee Road (April 2002)
- San Francisquito Levee Project (June 2002)
- Lower Guadalupe Flood Protection Project (January 2003)
- Lower Silver Creek, Reach 3, Phase 1 Flood Protection Project (April 2003)
- Lower Silver Creek, Reach 3, Phase 2 Flood Protection Project (May 2004)
- Lower Silver Creek, Reach 3, Phase 3 Flood Protection Project (March 2005)
- Coyote Parkway Freshwater Wetland Project (July 2006)
- Calabazas Creek Improvement Central Expressway to El Camino Real (April 2007)
- Pajaro Basin Freshwater Wetland Project (July 2007)
- Adobe Creek Upper Reach 5 Restoration Project (March 2008)

Analogous cost estimating was used to determine the unit costs listed below. The source of each unit cost is also listed.

- precast concrete piles and installation of the piles (South Bay Salt Ponds Restoration Project Pond A8 project, May 2009)
- tennis courts and play structure (City of El Centro – Parks and Recreation Master Plan, March 2008)

Vendor quotes, information from District staff, and reference manuals were used for the following unit costs:

- erosion control fabric (various sources provided by Judy Ingols, Vegetation Management Unit)
- geotextile (US Fabrics)
- tide gate (Waterman)
- slide gate (Waterman)
- prefabricated bridge (Echo Bridge South and additional sources provided by Minh-Tri Nguyen, Capital Program Services)
- bridge installation (Minh-Tri Nguyen)
- reinforced concrete pipe (RS Means)

Sediment Disposal

The project team has been asked to investigate alternative methods for disposal of sediments excavated for the purposes of construction. As part of the design phase, the project team will look into the possibility of disposal of sediments within Pond A4.

Erosion Protection Cost

Erosion protection expenditures are the same for each of the alternatives and are listed in the cost estimates as a lump sum. A lump sum breakdown is included at the end of this appendix.

2.1.2 Land Acquisition Unit Cost

Two right of way planning estimates were prepared by the Real Estate Services Unit for land acquisition costs. The first was prepared in January 2009 and covers parcels along Sunnyvale East and West Channels south of the San Francisco Bay Shoreline. The second was prepared in November 2009 and covers lands adjacent Sunnyvale East and West Channel and adjacent Pond A4 within the San Francisco Bay.

Table B2. Land Acquisition Unit Cost

Location	Cost	Unit
Upstream (south) Highway 101	$100	SF
Between Highway 101 and Highway 237	$125	SF
Highway 237 to San Francisco Bay Shoreline	$75	SF
Within San Francisco Bay	$0.50	SF

Additionally, the project team has estimated the cost of staff's time (engineering, real estate, HSLA, surveying, etc) to acquire each property to be $60,000. This is applied to each parcel as a purchase contract cost.

2.2 Feasible Alternative Capital Cost Summary

This section provides the preliminary cost estimates for each feasible alternative. The costs are separated into three groups: construction costs, land acquisition cost, and the total project cost which incorporates the construction and land acquisition costs. The construction costs are grouped by elements: floodwalls, levees, detention, Pond A4, and erosion protection while the land acquisition costs are grouped by reaches. Additionally, the project team is using a 35% contingency estimate which is only applied to the construction costs (AACE International Recommended Practice No. 18R-97). The 35% contingency estimate covers uncertainties associated with potential settlement issues, unknown utility locations, potential bridge replacements/headwall improvements, floodwall-bridge transitions at road crossings, and habitat issues associated with Pond A4.

2.2.1 Feasible Alternative B – Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Floodwall Construction				
Sunnyvale East				
Excavation	$ 28	CY	35,817	$ 1,002,876
Disposal of Sediment	$ 48	TON	12,131	$ 582,288
Fill	$ 18	CY	26,831	$ 482,958
Concrete	$ 1,040	CY	11,781	$ 12,252,240
Sunnyvale West				
Excavation	$ 28	CY	18,355	$ 513,940
Disposal of Sediment	$ 48	TON	6,198	$ 297,504
Fill	$ 18	CY	13,764	$ 247,752
Concrete	$ 1,040	CY	5,961	$ 6,199,440
Levee Construction				
Sunnyvale East				
Fill	$ 18	CY	41,848	$ 753,264
Sunnyvale West				
Fill	$ 18	CY	61,578	$ 1,108,404
Erosion Protection				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 29,256,059
Construction Contingencies (35%) =				$ 10,239,621
Total Construction Costs =				**$39,495,680**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	7,763	$ 776,300
Hwy 101 - 237	$ 125	SF	15,840	$ 1,980,000
DS Hwy 237	$ 75	SF	-	$ -
Purchase Contracts	$ 60,000	Each	9	$ 540,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	-	$ -
DS Hwy 237 - Shoreline	$ 75	SF	49,128	$ 3,684,600
Shoreline - Confluence	$ 0.50	SF	548,607	$ 274,304
Purchase Contracts	$ 60,000	Each	12	$ 720,000
Land Acquisition Cost =				**$ 7,975,204**
Total Project Costs =				**$47,470,883**
Total Project Costs (to the nearest $100,000) =				**$47,500,000**

2.2.2 Feasible Alternative D – Detention, Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Floodwall Construction				
Sunnyvale East				
Excavation	$ 28	CY	31,460	$ 880,880
Disposal of Sediment	$ 48	TON	10,542	$ 506,016
Fill	$ 18	CY	23,651	$ 425,718
Concrete	$ 1,040	CY	10,108	$ 10,512,320
Sunnyvale West				
Excavation	$ 28	CY	18,355	$ 513,940
Disposal of Sediment	$ 48	TON	6,198	$ 297,504
Fill	$ 18	CY	13,764	$ 247,752
Concrete	$ 1,040	CY	5,961	$ 6,199,440
Levee Construction				
Sunnyvale East				
Fill	$ 18	CY	41,801	$ 752,418
Sunnyvale West				
Fill	$ 18	CY	61,578	$ 1,108,404
Detention Area				
Earthwork				
Clear & grub	$ 13,223	Acre	4	$ 52,892
Excavation	$ 28	CY	44,714	$ 1,251,992
Disposal of Sediment	$ 48	TON	60,364	$ 2,897,472
Vegetation				
Hydro-seed	$ 3,329	Acre	4	$ 13,316
Sports Field				
Tennis courts	$ 64,200	per item	2	$ 128,400
Play structure	$ 40,072	per item	1	$ 40,072
Erosion Protection				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 31,643,929
Construction Contingencies (35%) =				$ 11,075,375
Total Construction Costs =				**$42,719,304**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	0	$ -
Hwy 101 - 237	$ 125	SF	15,833	$ 1,979,125
DS Hwy 237	$ 75	SF	-	$ -
Purchase Contracts	$ 60,000	Each	2	$ 120,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	-	$ -
DS Hwy 237 - Shoreline	$ 75	SF	49,128	$ 3,684,600
Shoreline - Confluence	$ 0.50	SF	548,607	$ 274,304
Purchase Contracts	$ 60,000	Each	12	$ 720,000
Joint Use Agreement				
Detention Areas	$ 50,000	Each	1	$ 50,000
Land Acquisition Cost				**$ 6,828,029**
Total Project Costs =				**$49,547,333**
Total Project Costs (to the nearest $100,000) =				**$49,600,000**

2.2.3 Feasible Alternative H – Pond A4, Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Floodwalls				
Sunnyvale East				
Excavation	$ 28	CY	28,554	$ 799,512
Disposal of Sediment	$ 48	TON	9,265	$ 444,720
Fill	$ 18	CY	21,691	$ 390,438
Concrete	$ 1,040	CY	8,685	$ 9,032,400
Sunnyvale West				
Excavation	$ 28	CY	14,325	$ 401,100
Disposal of Sediment	$ 48	TON	4,520	$ 216,960
Fill	$ 18	CY	10,977	$ 197,586
Concrete	$ 1,040	CY	4,177	$ 4,344,080
Levees				
Sunnyvale East				
Fill	$ 18	CY	0	$ -
Sunnyvale West				
Fill	$ 18	CY	14,994	$ 269,892
Pond A4				
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454
Bridges Installation	$ 47,364	Each	2	$ 94,728
Precast Piles	$ 48	LF	8,640	$ 414,720
Piles Installation	$ 3,411	EA	144	$ 491,184
Excavation	$ 28	CY	16,187	$ 453,236
Concrete (for box culverts on	$ 1,040	CY	470	$ 488,800
Fill (for levees and dams)	$ 18	CY	29,773	$ 535,914
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896
Tide Gate	$ 46,981	Each	5	$ 234,905
Slide Gate	$ 67,333	Each	1	$ 67,333
Rock Slope Protection	$ 61	TON	5,059	$ 308,599
Erosion Control				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 26,239,850
Construction Contingencies (35%) =				$ 9,183,948
Total Construction Costs =				**$35,423,798**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	7,635	$ 763,500
Hwy 101 - 237	$ 125	SF	15,840	$ 1,980,000
DS Hwy 237	$ 75	SF	0	$ -
Purchase Contracts	$ 60,000	Each	9	$ 540,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	0	$ -
DS Hwy 237 - Shoreline	$ 75	SF	47,400	$ 3,555,000
Purchase Contracts	$ 60,000	Each	7	$ 420,000
Pond A4				
NE Side (for Pilot Channel)	$ 0.50	SF	6,360	$ 3,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000
Land Acquisition Cost =				**$ 7,321,680**
Total Project Costs =				**$42,745,478**
Total Project Costs (to the nearest $100,000) =				**$42,800,000**

2.2.4 Feasible Alternative I – Pond A4, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Levee Construction				
Sunnyvale East				
Fill	$ 18	CY	188,838	$ 3,399,084
Sunnyvale West				
Fill	$ 18	CY	43,932	$ 790,776
Pond A4				
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454
Bridges Installation	$ 47,364	Each	2	$ 94,728
Precast Piles	$ 48	LF	8,640	$ 414,720
Piles Installation	$ 3,411	EA	144	$ 491,184
Excavation	$ 28	CY	16,187	$ 453,236
Concrete (for box culverts	$ 1,040	CY	470	$ 488,800
Fill (for levees and dams)	$ 18	CY	29,773	$ 535,914
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896
Tide Gate	$ 46,981	Each	5	$ 234,905
Slide Gate	$ 67,333	Each	1	$ 67,333
Rock Slope Protection	$ 61	TON	5,059	$ 308,599
Erosion Control				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 14,333,022
Construction Contingencies (35%) =				$ 5,016,558
Total Construction Costs =				**$ 19,349,580**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	31,525	$ 3,152,500
Hwy 101 - 237	$ 125	SF	144,733	$ 18,091,625
DS Hwy 237	$ 75	SF	14,111	$ 1,058,325
Purchase Contracts	$ 60,000	Each	22	$ 1,320,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	0	$ -
Hwy 237 - Shoreline	$ 75	SF	84,774	$ 6,358,050
Purchase Contracts	$ 60,000	Each	21	$ 1,260,000
Pond A4				
NE Side (for Pilot Channel)	$ 0.50	SF	6,360	$ 3,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000
Land Acquisition Costs =				**$ 31,303,680**
Total Project Costs =				**$ 50,653,260**
Total Project Costs (to the nearest $100,000) =				**$ 50,700,000**

2.2.5 Feasible Alternative J – Pond A4, Detention, Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Floodwall Construction				
Sunnyvale East				
Excavation	$ 28	CY	24,102	$ 674,856
Disposal of Sediment	$ 48	TON	7,619	$ 365,712
Fill	$ 18	CY	18,458	$ 332,244
Concrete	$ 1,040	CY	7,033	$ 7,314,320
Sunnyvale West				
Excavation	$ 28	CY	14,325	$ 401,100
Disposal of Sediment	$ 48	TON	4,520	$ 216,960
Fill	$ 18	CY	10,977	$ 197,586
Concrete	$ 1,040	CY	4,177	$ 4,344,080
Levee Construction				
Sunnyvale East				
Fill	$ 18	CY	0	$ -
Sunnyvale West				
Fill	$ 18	CY	14,994	$ 269,892
Detention Area				
Earthwork				
Clear & grub	$ 13,223	Acre	4	$ 52,892
Excavation	$ 28	CY	44,714	$ 1,251,992
Disposal of Sediment	$ 48	TON	60,364	$ 2,897,472
Vegetation				
Hydroseed	$ 3,329	Acre	4	$ 13,316
Sports Field				
Tennis courts	$ 64,200	per item	2	$ 128,400
Play structure	$ 40,072	per item	1	$ 40,072
Pond A4				
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454
Bridges Installation	$ 47,364	Each	2	$ 94,728
Precast Piles	$ 48	LF	8,640	$ 414,720
Piles Installation	$ 3,411	EA	144	$ 491,184
Excavation	$ 28	CY	16,187	$ 453,236
Concrete (for box culverts	$ 1,040	CY	470	$ 488,800
Fill (for levees and dams)	$ 18	CY	29,773	$ 535,914
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896
Tide Gate	$ 46,981	Each	5	$ 234,905
Slide Gate	$ 67,333	Each	1	$ 67,333
Rock Slope Protection	$ 61	TON	5,059	$ 308,599
Erosion Control				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 28,644,056
Construction Contingencies (35%) =				$ 10,025,420
Total Construction Costs =				**$38,669,476**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	0	$ -
Hwy 101 - 237	$ 125	SF	15,840	$ 1,980,000
DS Hwy 237	$ 75	SF	0	$ -
Purchase Contracts	$ 60,000	Each	2	$ 120,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	0	$ -
DS Hwy 237	$ 75	SF	47,400	$ 3,555,000
Purchase Contracts	$ 60,000	Each	7	$ 420,000
Pond A4				
NE Side	$ 0.50	SF	6,360	$ 3,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000
Joint Use Agreement				
Detention Areas	$ 50,000	Each	1	$ 50,000
Land Acquisition Cost				**$ 6,188,180**
Total Project Costs =				**$44,857,656**
Total Project Costs (to the nearest $100,000) =				**$44,900,000**

2.2.6 Feasible Alternative K – Pond A4, Detention, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost
Levee Construction				
Sunnyvale East				
Fill	$ 18	CY	174359	$ 3,138,462
Sunnyvale West				
Fill	$ 18	CY	43932	$ 790,776
Detention				
Earthwork				
Clear & grub	$ 13,223	Acre	4	$ 52,892
Excavation	$ 28	CY	44,714	$ 1,251,992
Sediment Disposal	$ 48	TON	60,364	$ 2,897,472
Vegetation				
Hydroseed	$ 3,329	Acre	4	$ 13,316
Sports Field				
Tennis courts	$ 64,200	per item	2	$ 128,400
Play structure	$ 40,072	per item	1	$ 40,072
Pond A4				
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454
Bridges Installation	$ 47,364	Each	2	$ 94,728
Precast Piles	$ 48	LF	8,640	$ 414,720
Piles Installation	$ 3,411	EA	144	$ 491,184
Excavation	$ 28	CY	16,187	$ 453,236
Concrete (for box culverts	$ 1,040	CY	470	$ 488,800
Fill (for levees and dams)	$ 18	CY	29,773	$ 535,914
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896
Tide Gate	$ 46,981	Each	5	$ 234,905
Slide Gate	$ 67,333	Each	1	$ 67,333
Rock Slope Protection	$ 61	TON	5,059	$ 308,599
Erosion Control				
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183
Subtotal =				$ 18,456,544
Construction Contingencies (35%) =				$ 6,459,790
Total Construction Costs =				**$24,916,334**
Land Acquisition				
Sunnyvale East				
US Hwy 101	$ 100	SF	0	$ -
Hwy 101 - 237	$ 125	SF	129,409	$ 16,176,125
DS Hwy 237	$ 75	SF	13,595	$ 1,019,625
Purchase Contracts	$ 60,000	Each	11	$ 660,000
Sunnyvale West				
Hwy 101 - 237	$ 125	SF	0	$ -
Hwy 237 - Shoreline	$ 75	SF	84,774	$ 6,358,050
Purchase Contracts	$ 60,000	Each	21	$ 1,260,000
Pond A4				
NE Side (for Pilot Channel)	$ 0.50	SF	6,360	$ 3,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000
Joint Use Agreement				
Detention Areas	$ 50,000	Each	1	$ 50,000
Land Acquisition Cost				**$25,586,980**
Total Project Costs =				**$50,503,314**
Total Project Costs (to the nearest $100,000) =				**$50,500,000**

2.3 Recommended Alternative Development

Using the Natural Flood Protection evaluation process, the project team has identified the three top-ranking feasible alternatives:

- Alternative B: Floodwalls, Levees and Erosion Protection
- Alternative H: Pond A4, Floodwalls, Levees and Erosion Protection
- Alternative J: Pond A4, Detention, Floodwalls, Levees and Erosion Protection.

The project team conducted additional data collection and investigative activities to refine the design details and to evaluate potential impacts associated with each alternative. The costs presented in this section have been updated to incorporate changes as a result of these necessary investigations.

2.3.1 Refined Alternative B – Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost	Subtotal
Floodwall Construction					
Sunnyvale East					
Excavation	$ 28	CY	34,466	$ 965,048	$ 13,837,856
Disposal of Sediment	$ 48	TON	11,705	$ 561,840	
Fill	$ 18	CY	25,796	$ 464,328	
Concrete	$ 1,040	CY	11,391	$ 11,846,640	
Sunnyvale West					
Excavation	$ 28	CY	19,208	$ 537,824	$ 8,251,662
Disposal of Sediment	$ 48	TON	6,741	$ 323,568	
Fill	$ 18	CY	14,215	$ 255,870	
Concrete	$ 1,040	CY	6,860	$ 7,134,400	
Levee Construction					
Sunnyvale East					
Fill	$ 18	CY	35,381	$ 636,858	$ 636,858
Sunnyvale West					
Fill	$ 18	CY	84,591	$ 1,522,638	$ 1,522,638
Erosion Protection					
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183	$ 3,627,183
			Subtotal =	$ 30,064,407	
			Construction Contingencies (35%) =	$ 10,522,542	
			Total Construction Costs =	**$ 40,586,949**	
Land Acquisition					
Sunnyvale East					
US Hwy 101	$ 100	SF	5,968	$ 596,800	$ 2,117,675
Hwy 101 - 237	$ 125	SF	10,727	$ 1,340,875	
DS Hwy 237	$ 75	SF	-	$ -	
Purchase Contracts	$ 60,000	Each	3	$ 180,000	
Sunnyvale West					
Hwy 101 - 237	$ 125	SF	-	$ -	$ 4,556,180
DS Hwy 237 - Shoreline	$ 75	SF	48,079	$ 3,605,925	
Shoreline - Confluence	$ 0.50	SF	580,509	$ 290,255	
Purchase Contracts	$ 60,000	Each	11	$ 660,000	
			Land Acquisition Cost =	**$ 6,673,855**	
			Total Project Costs =	**$ 47,260,804**	
			Total Project Costs (to the nearest $100,000) =	**$ 47,300,000**	

2.3.2 Refined Alternative H – Pond A4, Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost	Subtotal
Floodwalls					
Sunnyvale East					
Excavation	$ 28	CY	27,792	$ 778,176	$ 10,454,384
Disposal of Sediment	$ 48	TON	9,061	$ 434,928	
Fill	$ 18	CY	21,080	$ 379,440	
Concrete	$ 1,040	CY	8,521	$ 8,861,840	
Sunnyvale West					
Excavation	$ 28	CY	12,547	$ 351,316	$ 4,189,458
Disposal of Sediment	$ 48	TON	3,731	$ 179,088	
Fill	$ 18	CY	9,783	$ 176,094	
Concrete	$ 1,040	CY	3,349	$ 3,482,960	
Levees					
Sunnyvale East					
Fill	$ 18	CY	-	$ -	$ -
Sunnyvale West					
Fill	$ 18	CY	7,991	$ 143,838	$ 143,838
Pond A4					
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454	$ 4,571,609
Bridges Installation	$ 47,364	Each	2	$ 94,728	
Precast Piles	$ 48	LF	8,640	$ 414,720	
Piles Installation	$ 3,411	EA	144	$ 491,184	
Excavation	$ 28	CY	16,187	$ 453,236	
Concrete (for box culverts on NE	$ 1,040	CY	470	$ 488,800	
Fill (for levees and dams)	$ 18	CY	34,653	$ 623,754	
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896	
Tide Gate	$ 46,981	Each	5	$ 234,905	
Slide Gate	$ 67,333	Each	1	$ 67,333	
Rock Slope Protection	$ 61	TON	5,059	$ 308,599	
WPCP 48" RCP Pipe Extension	$ 208	LF	750	$ 156,000	
Erosion Control					
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183	$ 3,627,183
Subtotal =				$ 25,174,682	
Construction Contingencies (35%) =				$ 8,811,139	
Total Construction Costs =				**$ 33,985,821**	
Land Acquisition					
Sunnyvale East					
US Hwy 101	$ 100	SF	5,968	$ 596,800	$ 2,087,675
Hwy 101 - 237	$ 125	SF	10,487	$ 1,310,875	
DS Hwy 237	$ 75	SF	-	$ -	
Purchase Contracts	$ 60,000	Each	3	$ 180,000	
Sunnyvale West					
Hwy 101 - 237	$ 125	SF	-	$ -	$ 861,975
DS Hwy 237 - Shoreline	$ 75	SF	9,093	$ 681,975	
Purchase Contracts	$ 60,000	Each	3	$ 180,000	
Pond A4					
NE Side (for Pilot Channel)	$ 0.50	SF	6,360	$ 3,180	$ 63,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000	
Land Acquisition Cost =				**$ 3,012,830**	
Total Project Costs =				**$ 36,998,651**	
Total Project Costs (to the nearest $100,000) =				**$ 37,000,000**	

2.3.3 Refined Alternative J – Pond A4, Detention, Floodwalls, Levees and Erosion Protection

Item	Unit Cost	Unit	Quantity	Cost	Subtotal
Floodwall Construction					
Sunnyvale East					
Excavation	$ 28	CY	24,419	$ 683,732	$ 8,859,248
Disposal of Sediment	$ 48	TON	7,783	$ 373,584	
Fill	$ 18	CY	18,654	$ 335,772	
Concrete	$ 1,040	CY	7,179	$ 7,466,160	
Sunnyvale West					
Excavation	$ 28	CY	12,547	$ 351,316	$ 4,189,458
Disposal of Sediment	$ 48	TON	3,731	$ 179,088	
Fill	$ 18	CY	9,783	$ 176,094	
Concrete	$ 1,040	CY	3,349	$ 3,482,960	
Levee Construction					
Sunnyvale East					
Fill	$ 18	CY	-	$ -	$ -
Sunnyvale West					
Fill	$ 18	CY	7,991	$ 143,838	$ 143,838
Detention Area					
Earthwork					$ 4,656,848
Clear & grub	$ 13,223	Acre	5.5	$ 72,727	
Excavation	$ 28	CY	47,385	$ 1,326,780	
Disposal of Sediment	$ 48	TON	63,970	$ 3,070,560	
Vegetation					
Hydroseed	$ 3,329	Acre	5.5	$ 18,310	
Sports Field					
Tennis courts	$ 64,200	per item	2	$ 128,400	
Play structure	$ 40,072	per item	1	$ 40,072	
Pond A4					
Prefabricated Bridge	$ 94,727	Each	2	$ 189,454	$ 4,571,609
Bridges Installation	$ 47,364	Each	2	$ 94,728	
Precast Piles	$ 48	LF	8,640	$ 414,720	
Piles Installation	$ 3,411	EA	144	$ 491,184	
Excavation	$ 28	CY	16,187	$ 453,236	
Concrete (for box culverts	$ 1,040	CY	470	$ 488,800	
Fill (for levees and dams)	$ 18	CY	34,653	$ 623,754	
Disposal of Sediment	$ 48	TON	21,852	$ 1,048,896	
Tide Gate	$ 46,981	Each	5	$ 234,905	
Slide Gate	$ 67,333	Each	1	$ 67,333	
Rock Slope Protection	$ 61	TON	5,059	$ 308,599	
WPCP 48" RCP Pipe Extensio	$ 208	LF	750	$ 156,000	
Erosion Control					
Sunnyvale East	$ 2,188,210	LS	1	$ 2,188,210	$ 2,188,210
Sunnyvale West	$ 3,627,183	LS	1	$ 3,627,183	$ 3,627,183
Subtotal =				$ 28,236,394	
Construction Contingencies (35%) =				$ 9,882,738	
Total Construction Costs =				**$ 38,119,132**	
Land Acquisition					
Sunnyvale East					
US Hwy 101	$ 100	SF	-	$ -	$ 1,254,750
Hwy 101 - 237	$ 125	SF	9,558	$ 1,194,750	
DS Hwy 237	$ 75	SF	-	$ -	
Purchase Contracts	$ 60,000	Each	1	$ 60,000	
Sunnyvale West					
Hwy 101 - 237	$ 125	SF	-	$ -	$ 861,975
DS Hwy 237	$ 75	SF	9,093	$ 681,975	
Purchase Contracts	$ 60,000	Each	3	$ 180,000	
Pond A4					
NE Side	$ 0.50	SF	6,360	$ 3,180	$ 63,180
Purchase Contracts	$ 60,000	Each	1	$ 60,000	
Joint Use Agreement					
Detention Areas	$ 50,000	Each	1	$ 50,000	$ 50,000
Land Acquisition Cost				**$ 2,229,905**	
Total Project Costs =				**$ 40,349,037**	
Total Project Costs (to the nearest $100,000) =				**$ 40,300,000**	

3 Operations and Maintenance Costs

Operations and maintenance costs were calculated for each alternative by activity.
The following activities were identified:

- Graffiti removal (floodwalls)
- Increased mowing and weed control (levees)
- Detention basin operations and maintenance
- Pond A4 operations and maintenance

Only new maintenance activities required by each alternative are included in this cost estimate, existing maintenance costs are not identified.

The total cost for operations and maintenance by alternative is summarized in the table below. Costs were escalated to the 50-year total value using a 3.7% compounding interest rate. Additional information on how each activity was calculated can be found in the following sections.

Table B3. Operations and Maintenance Costs by Alternative

Activity	Alternative					
	B	D	H	I	J	K
Graffiti	$ 19,800	$ 12,320	$ 19,800	$ -	$ 12,320	$ -
Increased Mowing and Weed Control	$ -	$ -	$ -	$ 4,323	$ -	$ 3,537
Detention Basin	$ -	$ 4,719	$ -	$ -	$ 4,719	$ 4,719
Pond A4	$ -	$ -	$ 29,840	$ 29,840	$ 29,840	$ 29,840
Total per Year	$ 19,800	$ 17,039	$ 49,640	$ 34,163	$ 46,879	$ 38,096
Total per Year (nearest 1000)	**$ 20,000**	**$ 17,000**	**$ 50,000**	**$ 34,000**	**$ 47,000**	**$ 38,000**
Over 50-Years (includes escalation costs)	**$ 2,907,282**	**$ 2,471,189**	**$ 7,268,204**	**$ 4,942,379**	**$ 6,832,112**	**$ 5,523,835**

3.1 Graffiti Removal

Graffiti removal would increase for the alternatives that include floodwalls (B, D, H, and J). Floodwall locations for B and H are the same, as are the locations for D and J. Details of the locations for each alternative can be found in the project working files.

The removal plan is based on the existing Good Neighbor Program (Program), which specifies that graffiti will be removed four times per year in predetermined hotspots. The hours worked to remove graffiti in the current hotspots along both Sunnyvale East and West for FY05/06 thru FY09/10 were obtained from Chad Grande of the Lower Peninsula/West Valley Watershed Field Operations Unit. This work mostly involves removing graffiti from culverts and transition areas. An average of the hours per event per location was calculated from this data and then tripled to account for the proposed new work upstream and downstream of the existing Program-serviced locations and a safety factor. It was assumed that the work could be completed by one worker at a rate of $110/hour, which includes labor, benefits, and overhead. This rate was calculated from the FY09/10 adopted budget rates per unit. A summary of the calculation is shown below.

Cost per Location = (average hours x 3) x (4 times per year) x (1 worker at $110/hour)

Table B4. Graffiti Removal Costs

	Location	Average hours per Event	New Hours (x3)	Times per Year	Total New Hours per year	Labor Rate ($)	Cost/Year
West	Caribbean	0.89	3	4	12	110	$ 1,320
	Java	0.72	2	4	8	110	$ 880
	Bordeaux	0.77	2	4	8	110	$ 880
	Mathilda	0.87	3	4	12	110	$ 1,320
	Ross	1.53	5	4	20	110	$ 2,200
East	Tasman/Persian	4	12	4	48	110	$ 5,280
	Ahwanee	0.89	3	4	12	110	$ 1,320
	Blythe	1.3	4	4	16	110	$ 1,760
	Duane	1.17	4	4	16	110	$ 1,760
	Wolfe	1.3	4	4	16	110	$ 1,760
	Kifer	1.34	4	4	16	110	$ 1,760
	Evelyn	1.53	5	4	20	110	$ 2,200

3.2 Increased Mowing and Weed Control

Mowing and weed control was assumed to increase for those alternatives that solely involve levee modification or construction (Alternatives I and K). Information on how the additional areas were calculated can be found in the project working files. The following cost information was provided by Judy Ingols of the Vegetation Management Unit and is based on FY09 costs per watershed:

- Herbicide application - $350/acre/year
- Mowing - $400/acre/year
- Weed abatement - $560/acre/year

Table B5. Mowing and Weed Control Costs

Activity	Cost	Alternative I		Alternative K	
	$/acre/year	Acres	Cost	Acres	Cost
herbicide applicatio	$ 350.00	3.30	$1,155.00	2.7	$ 945.00
mowing	$ 400.00	3.30	$1,320.00	2.7	$1,080.00
weed abatement	$ 560.00	3.30	$1,848.00	2.7	$1,512.00
TOTAL			**$4,323.00**		**$3,537.00**

3.3 Detention Area O&M

Operations and maintenance of the detention area was assumed to involve a monthly inspection of the inlet and outlet structures (two hours/event) and clean up of the facility after every flood event. The detention area is designed to flood approximately every seven years. It was assumed that site clean up after flood events would take a crew of three workers approximately five, nine -hour days to complete. The same hourly rate as graffiti removal was used for the basis of this calculation.

Detention O&M = monthly structure inspection + flood clean up (every 7 years)
= (2 hours/inspection x 12 inspection/year x $110/hr x 1 worker) + (5 days x 9 hours/day x $110/hour x 3 workers x 7 events per 50 years ÷ 50 years)
= 2640 + 2079 = $4719

3.4 Pond A4 O&M

Operations and maintenance of Pond A4 was assumed to involve a monthly inspection of the tide and slide gates (three hours/event), a twice annual inspection of the inlets to the pond from the channels (two hours/event), and annual sediment removal from the outlet channel to Pond A4 (assumed $25,000/event).

Pond A4 O&M = monthly structure inspection + biannual inlet inspection + outlet sediment removal
= (3 hours/inspection x 12 inspection/year x $110/hr x 1 worker) + (2 hours/inspection x 2 inspection/year x $110/hr x 1 worker x 2 inlets) + $25,000
= 3960 + 880 + 25000 = $29840

Erosion Protection Lump Sum Breakdown

Table B6. Erosion Protection Lump Sum Breakdown - Sunnyvale East Channel

								Cost														
Erosion Location		U/S Station (ft)	D/S Station (ft)	Length (ft)	General Description	Number of Banks Needing Repair	Length of Repair (ft)	Excavation		Rock		Earth Fill		Disposal of Excess Materials		Erosion Control Fabric		Geotextile		Hydroseed		Total
								CY	$	Tons	$	CY	$	Tons	$	SF	$	SF	$	acre	$	
1	**Dunholme to Carlise**	29,700	29,100	600	Slumping (as high as 5 to 6 feet) both banks	2	600	1,246	28	857	61	606	18	640	48	10,908	7	11,516	12	0.25	3,329	$ 344,173
2	**Ashbourne to Fremont**	27,471	27,436	35	Slumping along east bank only	1	35	36		29		14		22		256		393		0.01		$ 10,626
3	**Fremont to Crescent**	27,250	27,230	20	hardscape to natural transition both banks	2	20	54		39		25		29		458		523		0.01		$ 15,248
4	**Crescent to El Camino**	26,000	25,400	600	slumping failure both banks	2	600	1,419		1,105		595		824		10,706		14,841		0.25		$ 411,265
5	**Kifer to Pedestrian Bridge**	18,381	18,319	62	Sack failure on west bank	1	62	102		53		63		39		1,134		708		0.03		$ 25,629
6	**Arques to Wolfe**	16,330	15,880	450	West bank toe erosion and slumping failure	1	450	658		513		276		383		4,963		6,887		0.11		$ 190,820
7	**Wolfe to Duane**	15,241	14,916	325	Slumping failure and toe erosion both banks in between hardscape	2	325	758		832		137		621		2,462		11,183		0.06		$ 255,880
8	**Blythe to PG&E #3**	12,457	12,263	194	Slumping failure west bank	1	194	237		233		63		174		1,141		3,129		0.03		$ 75,970
9	**PG&E #3 to Hwy 101**	12,177	12,000	177	Slumping failure east bank	1	177	204		214		45		160		802		2,872		0.02		$ 67,401
10	**PG&E #3 to Hwy 101**	11,791	11,592	199	Slumping failure east bank	1	199	139		146		30		109		536		1,957		0.01		$ 45,839
11	**Highway 101 to PG&E #2**	10,354	9,754	600	Slumping failure east bank, actual erosion 3 smaller sections, assumed replace entire 600-ft length	1	600	830		891		165		665		2,965		11,969		0.07		$ 277,097
12	**PG&E #2 to Tasman**	9,352	9,282	70	Slumping failure east bank between hardscape	1	70	91		107		11		80		203		1,437		0.00		$ 31,778
13	**Tasman to PG&E #1**	8,281	7,427	854	3-feet toe erosion west bank	1	854	1,300		1,411		248		1,053		4,458		18,948		0.10		$ 436,394
	Total																					$ 2,188,120

Table B7. Erosion Protection Lump Sum Breakdown - Sunnyvale West Channel

								Cost														
	Erosion Location	**U/S STA**	**D/S STA**	**Length**	**General Description**	**Number of Banks Needing Repair**	**Length of Repair (ft)**	**Excavation**		**Rock**		**Earth Fill**		**Disposal of Excess Materials**		**Erosion Control Fabric**		**Geotextile**		**Hydroseed**		**Total**
								CY	**$**	**Tons**	**$**	**CY**	**$**	**Tons**	**$**	**SF**	**$**	**SF**	**$**	**acre**	**$**	
1	**Parking Lot Culvert to Highway 101**	15090	14880	210	Significant lateral toe erosion (3 -4 feet deep)	1	210	269	28	197	61	122	18	147	48	2,204	7	2,641	12	0.05	3,411	$ 76,092
2	**Highway 101 to Ross**	14655	14605	50	Toe erosion near gunny sack, 4-5 feet on right bank	1	50	60		44		28		33		501		588		0.01		$ 17,049
		14250	14220	30	Minor slumping failure on left bank	1	30	34		29		13		22		231		387		0.01		$ 10,306
3	**Mathilda to Bordeaux**	11473	10656	817	Toe erosion both banks	2	817	2,045		1,726		757		1,288		13,624		23,190		0.31		$ 612,701
4	**Bordeaux to Java**	10586	8714	1872	Both banks toe erosion and slumping	2	1872	4,335		4,206		1,196		3,139		21,524		56,499		0.49		$ 1,380,473
5	**Java to Caribbean**	8570	6718	1852	Both banks toe erosion and slumping	2	1852	4,289		4,469		955		3,335		17,183		60,026		0.39		$ 1,411,894
6	**Caribbean to Carl**	6500	6200	300	West bank toe erosion and slumping	1	300	363		373		84		279		1,511		5,014		0.03		$ 118,668
	Total																					**$ 3,627,183**

Santa Clara Valley Water District℠

Sunnyvale East Channel and Sunnyvale West Channel Flood Protection Project

Planning Study Report

Appendix C

Natural Flood Protection Evaluation

June 2010

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Sunnyvale East and West Channels Flood Protection Project

Natural Flood Protection (NFP) Criteria Ratings

Notes:

(1) Each NFP criterion is rated for each alternative

(2) Criterion rating guidance is from NFP manual, dated February 3, 2009

(3) Rating guidance is provided for Outstanding, Adequate, Poor, and Unacceptable ratings. Very good and Fair ratings are interpolated.

(4) The ratings are scored according to the following key:

5 = Outstanding
4 = Very good
3 = Adequate
2 = Fair
1 = Poor
0 = Unacceptable

(5) The following staff members participated in the rating process on January 26 and 27, 2010:

Bill Springer
Kristen O'Kane
Chad Grande
Liang Xu (Day 1 only)
Mohammad Khan (Day 1 only)
Navroop Jassal
Beth Dyer (Day 2 only)
Brett Calhoun (Day 2 only)
Sara Duckler
Bal Ganjoo
Emily Zedler (Day 1 only)
Metra Valle
Tiffany Hernandez
Judy Ingols
Melissa Carter

(6) The alternatives were analyzed. Further description of each alternative can be found in the Draft Feasible Alternatives Report.

Alternative A – No Project
Alternative B – Floodwalls, Levees, and Erosion Protection
Alternative D – Detention Area, Floodwalls, Levees, and Erosion Protection
Alternative H – Pond A4, Floodwalls, Levees, and Erosion Protection
Alternative I – Pond A4, Levees, and Erosion Protection
Alternative J – Pond A4, Detention Area, Floodwalls, Levees, and Erosion Protection
Alternative K – Pond A4, Detention Area, Levees, and Erosion Protection

Objective 1—Provide Protection from Flood Damage

Criterion 1: Safety – Protection of public safety if conditions exceed design assumptions

Rating Guidance:

Outstanding: Alternative continues to provide for public safety when flows exceed design flow (Q = 500-year)

Adequate: Alternative improves safety compared to existing conditions when flows exceed design flow (Q = 200-year)

Poor: Alternative provides safety only up to design flow (Q = 100-year)

Unacceptable: Flood hazard is increased relative to existing conditions for flows exceeding design flow

Alternative	Rating	# Score	Comments
A	Poor	1	Does not improve on current conditions.
B	Fair	2	200-year storm capacity, however if floodwalls were to fail it could result in danger to public safety
D	Adequate	3	200-year storm capacity. Braly Park detention eliminates floodwalls in upstream residential areas on East Channel. Detention area overflowing would be less dangerous than floodwall failure
H	Adequate	3	200-year capacity. Pond A4 = lower water surface elevation = lower floodwalls = less dangerous conditions if failure occurs
I	Adequate	3	Same as Alt H
J	Very Good	4	Combines benefits of Braly Park detention and Pond A4. See Alt D and H
K	Very Good	4	Same as Alt J

Objective 1—Flooding

Criterion 2: Economic Protection – Protection from damage due to floodwater, erosion or sediment for homes, schools, businesses, transportation systems and other infrastructure

Rating guidance:

Outstanding: exceeds federal and local standards for flood protection facilities.

Adequate: meets federal standards for flood protection facilities.

Poor: floods less than design flood may cause damage to instream features

Unacceptable: flows less than the design flood would likely cause substantial damage to instream features

Alternative	Rating	# Score	Comments
A	Poor	1	Does not improve on current conditions.
B	Adequate	3	All features will be designed to meet Corps of Engineers, FEMA, and District standards
D	Adequate	3	All features will be designed to meet Corps of Engineers, FEMA, and District standards
H	Fair	2	The existing levees around Pond A4 will not meet FEMA standards and will not be improved under this project.
I	Fair	2	Same as Alt H
J	Fair	2	Same as Alt H
K	Fair	2	Same as Alt H

Objective 1—Flooding

Criterion 3: Durability – Future District effort required to maintain design level of protection

Rating Guidelines:

Outstanding: level of protection virtually independent of future actions

Adequate: level of protection dependent on future actions which are realistic to apply

Poor: level of protection dependent on future actions which may be difficult to apply

Unacceptable: level of protection dependent on intense level of future action which may fail

Alternative	Rating	# Score	Comments
A	Unacceptable	0	Flood protection provided as needed with sand bags. Channel monitoring and repair required on a yearly basis due to erosion which threatens stability of flood protection facilities.
B	Outstanding	5	
D	Adequate	3	Detention basin would require monitoring storms and operation of inlet/outlet structures
H	Fair	2	Pond A4 would require operation of outlet structure and removal of sediment from outlet channel
I	Fair	2	Same as Alt H
J	Poor	1	Detention basin would require monitoring storms and operation of inlet/outlet structures. Pond A4 would require operation of outlet structure and removal of sediment from outlet channel.
K	Poor	1	Same as Alt J

Objective 1—Flooding

Criterion 4: Resiliency – Adaptability to future changes

Rating guidance:

Outstanding: Channel design would accommodate additional future features such as added capacity if needed.

Adequate: Channel design conveys runoff for the full build-out condition.

Poor: Channel designed to convey runoff from existing development.

Unacceptable: Channel design does not convey current design flows.

Alternative	Rating	# Score	Comments
A	Unacceptable	0	East Channel does not have 100-year capacity downstream of Tasman Drive. West Channel does not have 100-year capacity downstream of Mathilda Avenue
B	Adequate	3	Floodwall heights designed to provide protection from 2-feet of sea level rise. Floodwall footings not designed to allow for additional height, so if protection standards changed, walls would have to be rebuilt.
D	Adequate	3	Same as Alt B
H	Very Good	4	Pond A4 removes channels from tidal influence, which lowers water surface elevation. Floodwall footings not designed for additional height.
I	Outstanding	5	Reduces water surface elevation in channel. Floodwalls or additional soil could be added to levees to further increase capacity/freeboard.
J	Adequate	3	Combination of Alt D and H
K	Very Good	4	Combination of Alt D and I

Objective 1—Flooding

Criterion 5: Local Drainage – Support of local storm drain systems

Rating guidance:

Outstanding: alternative design improves local drainage in storm sewers

Adequate: alternative accommodates drainage input and does not exacerbate local flooding

Poor: alternative accommodates local drainage but may increase local flooding somewhat

Unacceptable: alternative does not accommodate local drainage systems

Alternative	Rating	# Score	Comments
A	Adequate	3	
B	Adequate	3	Does not decrease water surface elevation.
D	Very Good	4	Detention basin decreases water surface elevation between Iris and Highway 101 on East Channel
H	Adequate	3	Pond A4 lowers water surface elevation in downstream reaches, however much of storm drain system pumped to channel
I	Adequate	3	Same as Alt H
J	Very Good	4	Combination of Alt D and H
K	Very Good	4	Combination of Alt D and I

Objective 1—Flooding

Criterion 6: Time to Implementation – How quickly could flood protection elements become effective

Rating guidance:

Outstanding: least amount of time to implementation compared to other alternatives

Adequate: average amount of time compared to other alternatives

Poor: longest amount of time compared to other alternatives

Unacceptable: Indefinite time

Alternative	Rating	# Score	Comments
A	Outstanding	5	No changes = no time to implement
B	Adequate	3	Requires right of way acquisition
D	Very Good	4	Detention basin eliminates need for right of way acquisition in residential areas south of Highway 101 along East Channel
H	Fair	2	Pond A4 reduce height of needed floodwalls and therefore right of way needed, but will have a complex permitting process
I	Fair	2	Levees require large amount of right of way acquisition and Pond A4 will have complex permitting process
J	Poor	1	Most complex alternative and will therefore take the most time to implement
K	Poor	1	Most complex alternative and will therefore take the most time to implement

Objective 2—Support Ecologic Functions and Processes

Criterion 1: Meets Local Habitat Goals – Ability to meet habitat goals as defined from examining the watershed as a whole

Rating guidance:
Outstanding: alternative meets or exceeds local habitat goals

Adequate: alternative meets some local habitat goals and is not in conflict with others

Poor: alternative is in conflict with a few local habitat goals

Unacceptable: alternative is in conflict with most local habitat goals

Alternative	Rating	# Score	Comments
A	Adequate	3	See Habitat Goals Checklist on following page for details.
B	Adequate	3	See Habitat Goals Checklist on following page for details.
D	Adequate	3	See Habitat Goals Checklist on following page for details.
H	Adequate	3	See Habitat Goals Checklist on following page for details.
I	Adequate	3	See Habitat Goals Checklist on following page for details.
J	Adequate	3	See Habitat Goals Checklist on following page for details.
K	Adequate	3	See Habitat Goals Checklist on following page for details.

Habitat Goals Checklist

Source	**Goal**	**Alternatives**						
		A	B	D	H	I	J	K
Santa Clara County General Plan	*Water supply resources*							
	Restore wetlands, riparian areas, and other habitats that improve Bay water quality.	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	Habitat and biodiversity							
	Improve current knowledge and awareness of habitats and natural areas.	**	**	**	**	**	**	**
	Protect the biological integrity of critical habitat areas.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Encourage habitat restoration.	**X**	**X**	**X**	*	*	*	*
Watershed Management Initiative	Protect and/or restore streams, reservoirs, wetlands and the Bay for the benefit of fish, wildlife and human uses.	**X**	**X**	**X**	**X**	**X**	**X**	**X**
SCVWD Lower Peninsula Watershed Stewardship Plan	No independent goals, but requires consistency with District's Ends Policies.	See SCVWD Ends Policies ratings below						
SCVWD Ends Policies	E-2.2.2—There is a balance between the contributions of watersheds and streams in providing for public health and safety and in providing protection of natural resource benefits.	*	*	*	*	*	*	*
City of Sunnyvale General Plan	Land Use Policy R.1.11.2: Protect and preserve the diked wetland areas in the baylands which serve as either salt evaporation ponds or holding ponds for the wastewater treatment plant.	**	**	**	*	*	*	*
Bayland Goals Project 1999	Pond A-4 identified as having value as open water habitat.	**	**	**	*	*	*	*

Key to Status:

***	=	would exceed goal	X	=	would not meet goal
**	=	would meet goal	NA	**=**	goal not applicable (included to show context of other related goals)
*	=	would partially meet goal			

Objective 2—Support Ecologic Functions and Processes

Criterion 2: Habitat Provided – Assesses quality of habitat provided by alternative

Rating guidance:

Outstanding: relatively undisturbed habitat, native plants, high potential to meet needs of fish and wildlife in all phases of lifecycle

Adequate: Adequately support the needs of fish and wildlife in all phases of lifecycle

Poor: Alternative focuses primarily on special needs of threatened or endangered species

Unacceptable: does not provide any habitat value

Alternative	Rating	# Score	Comments
A	Very Good	4	See note 1 below.
B	Adequate	3	Channel conditions remain the same, however floodwalls and levees would provide a barrier for species trying to move to and from the channels to adjacent habitats
D	Adequate	3	Same as Alt B
H	Fair	2	Pond A4 would reduce the height of floodwalls/levees needed; however there are unknowns about how water quality and habitat changes in the channels and Pond A4 that need further analysis. See also note 2 below.
I	Fair	2	Same as Alt H
J	Fair	2	Same as Alt H
K	Fair	2	Same as Alt H

Note 1 - Evaluation was limited to Pond A4 and areas north of Caribbean Drive along both channels (currently tidally influenced) as these areas "provide the greatest habitat value and constitute the areas with the highest probability of supporting sensitive species" (SEW PDR, page 2-25).

Note 2 – Information about how changes to Pond A4 might affect the habitat of the pond was not available at the time of the review and therefore alternatives that included this element were rated Fair (Alts H, I, J, and K). A sensitivity analysis was preformed to see if changes to the ratings for this criterion would have an overall effect on which alternative is chosen. If habitat conditions in Pond A4 worsened as a result of the project, the overall rating for Objective 2 would remain Fair for Alts H - K. If conditions in Pond A4 improved to a Very Good or above rating, than the overall rating for Objective 2 would improve to Adequate for Alternatives H - K. This change would not change the top three alternatives, but would provide additional support for choosing Alt H or J over Alt D.

Objective 2—Support Ecologic Functions and Processes

Criterion 3: Sustainability of Habitat – Assesses intensity of future actions required to maintain design habitat quality

Rating guidance:

Outstanding: minimal channel maintenance, banks dynamically stable, vegetation to be self-sustaining

Adequate: periodic selective thinning of vegetation, banks dynamically stable, short-term establishment period needed

Poor: regular maintenance anticipated, channel banks may require stabilization over time, intervention needed to maintain vegetation over long term

Unacceptable: regular vegetation removal, unstable banks, constant irrigation needed

Alternative	Rating	# Score	Comments
A	Unacceptable	0	
B	Poor	1	Ability to apply geomorphology to create a “dynamically stable” channel is limited by right of way ability and the fact that these are constructed channels.
D	Poor	1	Same as Alt B
H	Fair	2	Removing the channels from tidal influence will eliminate the need for sediment removal in the downstream areas, making the channel inverts more stable.
I	Fair	2	Same as Alt H
J	Fair	2	Same as Alt H
K	Fair	2	Same as Alt H

Objective 2—Support Ecologic Functions and Processes

Criterion 4: Connectivity of Habitat – Assesses integration of habitat elements into surrounding landscape

Rating guidance:

Outstanding: continuous riparian corridor appropriately integrated, creek and floodplain connected laterally

Adequate: contiguous wildlife-accessible corridor connected to habitat mosaic, floodplain not fully connected (and not fully unconnected) to riparian zone

Poor: non-contiguous riparian wildlife corridor, floodplain not connected to riparian zone

Unacceptable: not integrated into surrounding habitat

Alternative	Rating	# Score	Comments
A	Unacceptable	0	Both channels flow through a highly developed mix of urban, commercial, industrial uses and are surrounded on all sides with fences.
B	Unacceptable	0	Floodwalls would create another “barrier” to the surrounding habitat
D	Unacceptable	0	Same as Alt B
H	Poor	1	Connection to Pond A4 may provide a chance for improvement between channel habitat and pond habitat. Upstream areas would remain as is.
I	Poor	1	Same as Alt H
J	Poor	1	Same as Alt H
K	Poor	1	Same as Alt H

Objective 3—Physical Stream Functions and Processes

Criterion 1: Floodplain – Inclusion of appropriately sized floodplain

Rating guidance:

Outstanding: active channel connected to floodplain at bankfull level, floodplain has adequate width.

Adequate: modified floodplain, active channel, limited r/w may require containment means, or bypass channel used

Poor: flow will not spread out laterally, multi-stage channel, but not at bankfull level

Unacceptable: single-phase channel

Alternative	Rating	# Score	Comments
A	Unacceptable	0	Constructed trapezoidal channel.
B	Unacceptable	0	Right of way is limited along the channels and the public has not expressed support for acquiring right of way to create a floodplain
D	Unacceptable	0	Same as Alt B
H	Unacceptable	0	Same as Alt B
I	Unacceptable	0	Same as Alt B
J	Unacceptable	0	Same as Alt B
K	Unacceptable	0	Same as Alt B

Objective 3—Physical Stream Functions and Processes

Criterion 2: Active Channel – Appropriateness of size and configuration of active channel

Rating guidance:

Outstanding: appropriate active channel shape, meander length, curve radius, amplitude, belt width, sediment carrying capability, mobile bed, pool riffle sequence, tidal processes. Control structures unnecessary.

Adequate: active channel with stable width and depth, rock or other hardscape used to prevent erosion, small drops, hardened one-side channels to maximize floodplain width

Poor: active channel incorporated, unknown if effective

Unacceptable: no active channel

Alternative	Rating	# Score	Comments
A	Unacceptable	0	Constructed trapezoidal channel.
B	Unacceptable	0	Right of way is limited along the channels and the public has not expressed support for acquiring right of way to create “active channel”
D	Unacceptable	0	Same as Alt B
H	Unacceptable	0	Same as Alt B
I	Unacceptable	0	Same as Alt B
J	Unacceptable	0	Same as Alt B
K	Unacceptable	0	Same as Alt B

Objective 3—Physical Stream Functions and Processes

Criterion 3: Stable Side Slopes – Stability of side slopes

Rating guidance:

Outstanding: all side slopes stable through use of proper slope ratios, materials, and vegetation

Adequate: side slopes protected through biotech means

Poor: side slopes protected using hardscape

Unacceptable: side slopes unstable and unprotected

Alternative	Rating	# Score	Comments
A	Unacceptable	0	
B	Fair	2	Erosion protection is the same for all alternatives and consists of rock toe protection with earth fill and vegetation on the banks. Sites will be investigated on a case by case basis to determine if other biotech methods are appropriate.
D	Fair	2	Same as Alt B
H	Fair	2	Same as Alt B
I	Fair	2	Same as Alt B
J	Fair	2	Same as Alt B
K	Fair	2	Same as Alt B

Objective 3—Physical Stream Functions and Processes

Criterion 4: Transitions – Stability of channel's integration with upstream and downstream reaches

Rating guidance:

Outstanding: invert integrated so that it transitions seamlessly with stable u/s and d/s reaches, no abrupt changes in grade or direction of flow

Adequate: requires small stabilizing grade controls (<18")

Poor: large (>18") hardscaped grade control needed

Unacceptable: unstable transitions between u/s and d/s reaches

Alternative	Rating	# Score	Comments
A		N/A	The project encompasses the entire channel.
B			
D			
H			
I			
J			
K			

Objective 4—Minimize Maintenance Requirements

Criterion 1: Structural Features – Maintenance associated with structures

Rating guidance:

Outstanding: no structural features requiring maintenance

Adequate: need for features requiring maintenance reduced compared to existing

Poor: maintenance required roughly similar to existing

Unacceptable: more structural features than existing

Alternative	Rating	# Score	Comments
A	Poor	1	Yearly repair of channels, post-flood clean up
B	Adequate	3	Erosion problems fixed
D	Fair	2	Erosion fixed, but operation and maintenance of detention basin added
H	Fair	2	Erosion fixed, but operation and maintenance of Pond A4 added
I	Fair	2	Same as Alt H
J	Poor	1	Erosion fixed, but operation and maintenance of detention basin and Pond A4 added
K	Poor	1	Same as Alt J

Objective 4 – Minimize Maintenance Requirements

Criterion 2: Natural Processes – Maintenance associated with vegetation, erosion, and sediment

Rating guidance:

Outstanding: sediment and vegetation removal and bank repair not expected in 100 years

Adequate: sediment and vegetation removal and bank repair expected to be infrequent (about 10 years apart), multi-stage channel used

Poor: sediment and vegetation removal and bank repair expected on about three year cycle, no multi-stage channel

Unacceptable: yearly maintenance expected, single-phase channel

Alternative	Rating	# Score	Comments
A	Unacceptable	0	Yearly repair of channels required under current conditions
B	Poor	1	Channels tidally influenced, which results in sediment removal needed every 3 year in downstream areas
D	Poor	1	Same as Alt B
H	Adequate	3	Channels removed from tidal influence and sedimentation
I	Fair	2	Channels removed from tidal influence and sedimentation, vegetation maintenance increased with levee area increase
J	Adequate	3	Same as Alt H
K	Fair	2	Same as Alt I

Objective 4—Minimize Maintenance Requirements

Criterion 3: Urban Flows – Maintenance resulting from small storms and outfall flows

Rating guidance:

Outstanding: maintenance requirements would be significantly reduced using outfall design, off-stream detention, grade control

Adequate: maintenance requirements would be somewhat reduced

Poor: maintenance requirements would be about the same

Unacceptable: much worse than current conditions

Alternative	Rating	# Score	Comments
A	Poor	1	Same as existing
B	Adequate	3	Erosion protection will stabilize channel and result in less erosion
D	Adequate	3	Same as Alt B
H	Very Good	4	Channels removed from tidal influence
I	Very Good	4	Same as Alt H
J	Very Good	4	Same as Alt H
K	Very Good	4	Same as Alt H

Objective 4—Minimize Maintenance Requirements

Criterion 4: Access – Incorporation of adequate access for maintenance crews and equipment

Rating guidance:

Outstanding: multi-function access corridors optimized based on expected project needs

Adequate: complies with District policy 3-410

Poor: access corridors provided but does not comply with 3-410

Unacceptable: inadequate or no access provided

Alternative	Rating	# Score	Comments
A	Fair	2	Channels currently have access, but roads not in compliance with 3-410
B	Adequate	3	All access roads will be designed using 3-410
D	Adequate	3	Same as Alt B
H	Adequate	3	Same as Alt B
I	Adequate	3	Same as Alt B
J	Adequate	3	Same as Alt B
K	Adequate	3	Same as Alt B

Objective 5—Integrate within the Watershed

Criterion 1: Meets Local Watershed Goals – Ability to meet watershed goals as defined in a process that examines the watershed as a whole

Rating guidance:

Outstanding: the alternative substantially advances watershed goals

Adequate: the alternative advances some goals and is not in conflict with any

Poor: the alternative is in conflict with a few major watershed goals

Unacceptable: the alternative is in conflict with several watershed goals

Alternative	Rating	# Score	Comments
A	Adequate	3	See Watershed Goals Checklist on following page for details
B	Adequate	3	See Watershed Goals Checklist on following page for details
D	Adequate	3	See Watershed Goals Checklist on following page for details
H	Adequate	3	See Watershed Goals Checklist on following page for details
I	Adequate	3	See Watershed Goals Checklist on following page for details
J	Adequate	3	See Watershed Goals Checklist on following page for details
K	Adequate	3	See Watershed Goals Checklist on following page for details

Watershed Goals Checklist

Source	**Goal**	**Alternative**						
		A	**B**	**D**	**H**	**I**	**J**	**K**
Santa Clara County General Plan	*Water quality and watershed management*							
	Reduce non-point source pollution.	*	*	*	*	*	*	*
	Prepare and implement comprehensive watershed management plans.	X	X	X	X	X	X	X
Watershed Management Initiative	Balance the objectives of water supply management, habitat protection, flood management and land use to protect and enhance water quality.	*	*	*	*	*	*	*
City of Sunnyvale General Plan	Land use policy R.1.11.2: protect and preserve the diked wetland areas in the baylands which serve as either salt evaporation ponds or holding ponds for the wastewater treatment.	**	**	**	*	*	*	*
SCVWD Lower Peninsula Watershed Stewardship Plan	No independent goals, but requires consistency with district Ends Policies.	See SCVWD End Policies rating below						
SCVWD Ends Policies	E-2.2.1—The cost of reducing the potential for flood damages is balanced with benefits (including possible environmental restoration and enhancement).	*	*	*	*	*	*	*
	E-2.2.2—There is a balance between the contributions of watersheds and streams in providing for public health and safety and in providing protection of natural resource benefits.	*	*	*	*	*	*	*
	E-3.1. Watersheds, streams, and the natural resources therein are protected and when appropriate enhanced or restored.	X	X	X	X	X	X	X

Key to Status:

***	=	would exceed goal	*	=	would partially meet goal
**	=	would meet goal	X	=	would not meet goal

NA **=** goal not applicable (included to show context of other related goals)

Objective 6—Protect the Quality and Availability of Water

Criterion 1: Water Availability – Impact on groundwater recharge

Rating guidance:

Outstanding: alternative would result in a net increase in recharge potential and improve functionality and performance of diversions

Adequate: no net change in recharge potential, diversions not negatively impacted

Poor: would reduce the potential for recharge, diversions not negatively impacted

Unacceptable: substantially reduces opportunity for recharge or degrade performance of diversions

Alternative	Rating	# Score	Comments
A	Adequate	3	East and West Channels are in the unconfined zone of the Santa Clara Valley groundwater subbasin. As this is not a recharge zone, there is not potential to increase recharge.
B	Adequate	3	Same as Alt A
D	Adequate	3	Same as Alt A
H	Adequate	3	Same as Alt A
I	Adequate	3	Same as Alt A
J	Adequate	3	Same as Alt A
K	Adequate	3	Same as Alt A

Objective 6—Protect the Quality and Availability of Water

Criterion 2: Groundwater Quality – Groundwater quality protection from contamination and the threat of contamination by preventing contamination entry into groundwater

Rating guidance:

Outstanding: maintains the minimum required separation for natural protection of groundwater, provides structural features to prevent contaminant entry into groundwater, includes BMPs to protect groundwater quality , and incorporates outreach to decrease pollution potential

Adequate: does not maintain the minimum required separation for natural protection of groundwater, however provides structural features to prevent contaminant entry into groundwater and includes BMPs to protect groundwater quality

Poor: does not maintain the minimum required separation for natural protection of groundwater, however includes BMPs to protect groundwater quality

Unacceptable: does not maintain the minimum required separation for natural protection of groundwater and does not include measures or programs to protect groundwater quality

Alternative	Rating	# Score	Comments
A	Very Good	4	
B	Very Good	4	All alternatives maintain a minimum required separation for natural protection of groundwater.
D	Very Good	4	Same as Alt B
H	Very Good	4	Same as Alt B
I	Very Good	4	Same as Alt B
J	Very Good	4	Same as Alt B
K	Very Good	4	Same as Alt B

Objective 6—Protect the Quality and Availability of Water

Criterion 3: Instream Water Quality – Water quality protection through vegetation and instream hydraulic complexity

Rating guidance:

Outstanding: alternative would improve water quality by creating a hydraulically complex channel and including native riparian vegetation in appropriate locations

Adequate: alternative would maintain current water quality conditions

Poor: alternative would reduce streamside vegetation and hydraulic complexity

Unacceptable: alternative would result in significant loss of vegetation, alternative would provide little or no hydraulic complexity

Alternative	Rating	# Score	Comments
A	Adequate	3	
B	Adequate	3	
D	Adequate	3	
H	Adequate	3	
I	Adequate	3	
J	Adequate	3	
K	Adequate	3	

Objective 6—Protect the Quality and Availability of Water

Criterion 4: Offstream Water Management – Ability to enhance water supply and quality and reduce peak flows through local retention of rainfall

Rating guidance:

Outstanding: alternative contains elements that significantly increase retention and use of rainwater, significantly reduces peak flows, includes educational programs

Adequate: moderately increases retention and use of rainwater, moderately reduces peak flows to the creeks, includes educational programs

Poor: alternative does not contain any such elements

Unacceptable: alternative would discourage local capture of rainfall/runoff

Alternative	Rating	# Score	Comments
A	Poor	1	
B	Poor	1	Same as existing conditions
D	Adequate	3	Detention basin at Braly Park reduces peak flow in the East Channel from Old San Francisco to Highway 101
H	Poor	1	Same as existing conditions
I	Poor	1	Same as existing conditions
J	Adequate	3	Same as Alt D
K	Adequate	3	Same as Alt D

Objective 6—Protect the Quality and Availability of Water

Criterion 5: Flow Regime – Ability to maintain geomorphically and biologically appropriate range of flows

Rating guidance:

Outstanding: alternative maintains locally appropriate seasonal variation in flows that will support an appropriate physical channel configuration and habitat

Adequate: alternative includes modification to the locally appropriate flow regime with no significant impact on channel stability or habitat

Poor: alternative includes significant modifications to natural flow regime which is likely to have an impact on channel stability or habitat

Unacceptable: modifications to flow regime are likely to have a significant impact on channel stability or habitat

Alternative	Rating	# Score	Comments
A	Adequate	3	
B	Adequate	3	
D	Adequate	3	
H	Adequate	3	Possible impacts to Pond A4, remaining East and West tidal spurs, and the Guad Slough system unknown
I	Adequate	3	Same as Alt H
J	Adequate	3	Same as Alt H
K	Adequate	3	Same as Alt H

Objective 7—Cooperate with Other Local Agencies to Achieve Mutually Beneficial Goals

Criterion 1: Mutual Local Goals – ability to achieve project-specific goals and objectives developed jointly by the District and local agencies

Rating guidance:

Outstanding: all goals and objectives developed in a Memorandum of Consensus (MOC) are met

Adequate: some goals and objectives developed in the MOC of all agencies are met

Poor: MOC is developed but only District goals and objectives are met

Unacceptable: few objectives met, or no MOC developed

Alternative	Rating	# Score	Comments
A	Unacceptable	0	
B	Unacceptable	0	No MOC developed. See note 1.
D	Unacceptable	0	Same as Alt B
H	Unacceptable	0	Same as Alt B
I	Unacceptable	0	Same as Alt B
J	Unacceptable	0	Same as Alt B
K	Unacceptable	0	Same as Alt B

Note 1 – A memorandum of consensus (MOC) has not been developed for the project and therefore all alternatives rated Unacceptable for this criteria. However, the project team assumes that any MOC developed would rate the same for all alternatives and therefore would not change the overall Objective 7 rating or the chosen alternative. The team is in the process of developing MOC's with the City of Sunnyvale and the Santa Clara Unified School District.

Objective 7—Supports General Plan – Ability to support goals and policies as stated in general plans of partner agencies

Rating guidance:

Outstanding: supports all pertinent general plan elements

Adequate: supports some general plan elements

Poor: does not support some general plan elements, is in conflict with few

Unacceptable: significant conflicts with major elements in general plans

Criterion 2: Supports General Plan

Alternative	Rating	# Score	Comments
A	Adequate	3	See General Plan Goals Checklist on following page for details
B	Adequate	3	See General Plan Goals Checklist on following page for details
D	Adequate	3	See General Plan Goals Checklist on following page for details
H	Adequate	3	See General Plan Goals Checklist on following page for details
I	Adequate	3	See General Plan Goals Checklist on following page for details
J	Adequate	3	See General Plan Goals Checklist on following page for details
K	Adequate	3	See General Plan Goals Checklist on following page for details

General Plan Goals Checklist

Source	Goal	Alternative						
		A	B	D	H	I	J	K
Santa Clara County General Plan	Develop parks and public open space lands.	X	X	X	X	X	X	X
	Minimize the resident population within high hazard areas.	*	*	*	*	*	*	*
	Reduce the magnitude of the hazard, if feasible.	*	*	*	*	*	*	*
City of Sunnyvale	Goal 2.2 A Open Space: The City strives to provide and maintain adequate and balanced open space and recreation facilities for the benefit of maintaining a healthy community based on community needs and the ability of the city to finance, construct, maintain, and operate these facilities now and in the future.	*	*	*	*	*	*	*

Key to Status:

*** = would exceed goal
** = would meet goal
* = would partially meet goal
X = would not meet goal
NA **=** goal not applicable (included to show context of other related goals)

Objective 8—Community Benefits beyond Flood Protection

Criterion 1: Community Safety – Overall safety for appropriate access and recreation

Rating guidance:

Outstanding: all safety issues identified by public safety officials during their review is addressed

Adequate: most safety issues identified addressed, explanation provided for features deemed inappropriate or infeasible

Poor: few if any recommendations incorporated into alternative

Unacceptable: alternative was not reviewed by public safety officials

Alternative	Rating	# Score	Comments
A	Unacceptable	0	No known safety evaluation of channels
B	Unacceptable	0	See note 1
D	Unacceptable	0	See note 1
H	Unacceptable	0	See note 1
I	Unacceptable	0	See note 1
J	Unacceptable	0	See note 1
K	Unacceptable	0	See note 1

Note 1 – A safety evaluation has not been completed for the project and therefore all alternatives rated Unacceptable for this criterion. A sensitivity analysis indicates that for Alts D, H, and J there would be no change in the overall Objective 8 rating no matter how the criterion rated. For Alts B, I, and K the overall objective rating could increase to a maximum of Fair if the criterion ratings were increased to Very Good or above. This would lessen the difference between the alternatives, but would not change the top three. Safety officials will be contacted prior to construction.

Objective 8—Community Benefits beyond Flood Protection

Criterion 2: Recreation – Quality of recreation experience provided by alternative

Rating guidance:

Outstanding: project would provide unique quality recreational opportunities or a variety of opportunities with good public access and amenities

Adequate: some recreational opportunities incorporated into alternative, access may be limited

Poor: few or no recreational facilities incorporated into alternative

Unacceptable: existing recreational facilities are removed

Alternative	Rating	# Score	Comments
A	Poor	1	Public access is currently prohibited along channels.
B	Poor	1	Per the project objectives, two opportunities for recreational enhancements are to be identified for Board consideration, however funding for these opportunities is not part of the project budget. None of the alternatives prevent recreational opportunities.
D	Poor	1	Same as Alt B.
H	Poor	1	Same as Alt B.
I	Poor	1	Same as Alt B.
J	Poor	1	Same as Alt B.
K	Poor	1	Same as Alt B.

Objective 8—Community Benefits beyond Flood Protection

Criterion 3: Aesthetics – Assesses quality of aesthetic form provided by alternative

Rating guidance:

Outstanding: this criteria is a qualitative assessment and features to consider include harmonizing with the landscape, emulating the natural environment, use of unexpected large/small features, concrete textured or formed to mimic natural features, creating a park-like setting, art use, including amenities such as benches, and being generally “clever”.

Unacceptable: hardscape significantly greater than greenscape, visual monotony, heavy use of plain concrete

Alternative	Rating	# Score	Comments
A	Fair	2	Straight, man-made trapezoidal channel with development surrounding it is visually monotonous
B	Poor	1	Adds floodwalls to already visual monotonous conditions
D	Poor	1	Same as Alt B
H	Fair	2	Pond A4 reduces height and extent of floodwalls to fair level.
I	Fair	2	Pond A4 reduces height of levees to fair level
J	Fair	2	Same as Alt H
K	Fair	2	Same as Alt I

Objective 8—Community Benefits beyond Flood Protection

Criterion 4: Social and Cultural Benefits – Opportunity to promote community involvement

Rating guidance:

Outstanding: includes appropriate infrastructure to support full range of social and cultural benefits

Adequate: includes appropriate infrastructure to support some social and cultural benefits

Poor: does not include appropriate infrastructure

Unacceptable: eliminates existing features or includes inappropriate features

Alternative	Rating	# Score	Comments
A	Poor	1	What would be socially or culturally appropriate for manmade drainage ditches?
B	Poor	1	
D	Poor	1	
H	Poor	1	
I	Poor	1	
J	Poor	1	
K	Poor	1	

Objective 8—Community Benefits beyond Flood Protection

Criterion 5: Local Economic Effects – Potential effect on property values and/or local business climate

Rating guidance:

Outstanding: probably increase in value of adjacent properties, commercial benefits to local businesses such as increased foot traffic, alternative increases development possibilities

Adequate: no measurable change to property values or local businesses

Poor: no change to property values, businesses negatively impacted

Unacceptable: decrease in property values and commercial access

Alternative	Rating	# Score	Comments
A	Poor	1	
B	Very good	4	
D	Very good	4	
H	Very good	4	
I	Very good	4	
J	Very good	4	
K	Very good	4	

Objective 8—Community Benefits beyond Flood Protection

Criterion 6: Green Construction and Operation – reflection of the District's commitment to minimize its impact on the environment

Rating guidance:

Outstanding: variety of features and methods incorporated to minimize resource use

Adequate: some features and measures are incorporated to minimize resource use, either during construction or within the completed project

Poor: missed opportunities for minimal resource use

Unacceptable: significantly increases non-renewable resource use over existing conditions and for the long term

Alternative	Rating	# Score	Comments
A			See note 1
B			See note 1
D			See note 1
H			See note 1
I			See note 1
J			See note 1
K			See note 1

Note 1 – This criterion was not evaluated as the project team had not completed the work required to do so at the time of the review. A sensitivity analysis indicates that for Alts A, D, H, and J there would be no change in the overall Objective 8 rating no matter how the criterion rated. For Alts B, I, and K the overall objective rating could increase to a maximum of Fair if the criterion ratings were increased to Very Good or above. This would lessen the difference between the alternatives, but would not change the top three. An evaluation of green construction and operation will be done as part of the CEQA analysis of the selected alternative.

Objective 8—Community Benefits beyond Flood Protection

Criterion 7: Open Space – Incorporation of open space into alternative design

Rating guidance:

Outstanding: ensures long-term protection of existing open space, creates new open space

Adequate: reserves existing open space in project area

Poor: existing open space would be degraded

Unacceptable: significant loss of existing open space

Alternative	Rating	# Score	Comments
A	Adequate	3	
B	Adequate	3	
D	Very Good	4	Ensures long-term protection of Braly Park, but does not create new open space
H	Very Good	4	Ensures long-term protection of Pond A4, but does not create new open space
I	Very Good	4	Same as Alt H
J	Very Good	4	Ensures long-term protection of Braly Park and Pond A4, but does not create new open space
K	Very Good	4	Same as Alt J

Objective 8—Community Benefits beyond Flood Protection

Criterion 8: Community Support – Alternative reflects community developed objectives and ideas

Rating guidance:

Outstanding: relative to other alternatives, community indicates preference for this alt

Adequate: community indicates acceptance of the alternative

Poor: community lacks support for the alternative

Unacceptable: community finds alternative unacceptable

Alternative	Rating	# Score	Comments
A	Unacceptable	0	
B	Fair	2	Highest floodwalls and land acquisition of the alternatives not including levees in the residential areas
D	Fair	3	Eliminates floodwalls in highly residential areas upstream of highway 101
H	Fair	3	Lowers floodwall height downstream of Highway 101
I	Poor	0	Input from community meeting indicates that public does not support the right of way acquisition that constructing levees requires
J	Fair	5	Eliminates floodwalls in highly residential areas upstream of highway 101 and lowers floodwall height downstream
K	Poor	0	Same as Alt I

Note – This rating is different than discussed in the evaluation meeting; however the project team feels it better represents the input received from the two community meetings and from numerous meeting with City of Sunnyvale staff.

Objective 9—Minimize Life-Cycle Costs

Criterion 1: Capital Cost

Net Present Value of estimated capital cost. This cost includes land acquisition and construction (which includes a 35% contingency).

The funding available for capital cost for this project is $28.9 million (2009 dollars)

Alternative	$NPV	Comments
A	0	
B	$44.9 million	$37 million construction, $7.9 million land acquisition
D	$46.8 million	$40 million construction, $6.8 million land acquisition
H	$40.4 million	$33.1 million construction, $7.3 million land acquisition
I	$49.4 million	$18.1 million construction, $31.3 million land acquisition
J	$42.4 million	$36.2 million construction, $6.2 million land acquisition
K	$48.9 million	$23.4 million construction, $25.5 million land acquisition

Criterion 2: Maintenance Cost

Net Present Value of all maintenance costs over the life of the project (50 years)

Alternative	$NPV	Comments
A		
B	$1.7 million	Additional graffiti removal
D	$1.5 million	Additional graffiti removal and detention maintenance
H	$4.4 million	Additional graffiti removal and Pond A4 maintenance
I	$3.0 million	Increased vegetation maintenance and Pond A4 maintenance
J	$4.1 million	Additional graffiti removal and Pond A4 and detention maintenance
K	$3.3 million	Increased vegetation maintenance and Pond A4 and detention maintenance

Criterion 2: Grant or cost sharing Net Present Value of grant or cost sharing opportunities for project or project components		
Alternative	**$NPV**	**Comments**
A	$0	
B	$0	
D	$0	Cost sharing opportunities for Braly detention area not yet negotiated
H	$0	
I	$0	
J	$0	Cost sharing opportunities for Braly detention area not yet negotiated
K	$0	Cost sharing opportunities for Braly detention area not yet negotiated